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REPORT OF THE FOURTH HUD/DOE NATIONAL DISTRICT HEATING AND COOLING CONFERENCE HELD IN WASHINGTON, D.C. JANUARY 21-22, 1986

compiled by

Caroline Brooks and Michael J. Meshenberg
Argonne National Laboratory
and
Maria Rivera
U.S. Conference of Mayors

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Introduction

This report on the fourth annual Housing and Urban Development and U.S. Department of Energy (HUD/DOE) National District Heating and Cooling Conference presents strong evidence of a movement from an idea to a reality. In past years, almost all speakers discussed prospective projects, those that were being considered or in some cases were close to fruition. This year, there were many more presentations on real projects. The changing balance in the speakers and their presentations over the years of these conferences is a microcosm of the changing nature of district heating and cooling in this country.

District Heating and Cooling (DHC) Evolution

There was far less talk this year about feasibility assessments and far more about development, more sharing of project management experience and less about early planning stages, and less skepticism and uncertainty about whether projects will work technically given growing practical experience that proves that engineering problems can be solved. Many of the speakers had worked on several projects, attesting to a broadening of individual experiences that could be shared with the audience.

Always, of course, there was talk about financing, perhaps more so this year in light of falling oil prices that may diminish DHC attractiveness as an investment, a federal deficit that reduces planning funds, and a tax structure that offers few incentives for district heating. That such projects can succeed in the face of financial obstacles is a testament to the fundamental soundness of the idea and the innovativeness of its proponents.

Given the experience rather than planning orientation of this year's conference, a few themes have emerged. Since the inception of this renewed interest in DHC, dated perhaps from the release of the first offer of funding support jointly by HUD and DOE in late 1980, promotion of the concept has always hinged on its long-term public benefits. The benefits were asserted as economic development, neighborhood revitalization, energy stability and savings, environmental improvements, and access to alternate fuels, among others. Assertions of these future benefits are now giving way to more hard-nosed analyses of actual experience, as the data are emerging from the first wave of newly-constructed, renovated, or expanded systems. The data, by definition, remain preliminary because the real effects can only be determined after systems have functioned for some time.

But what clearly can be derived from the experience of presenters at this conference is the importance of doing something. Enough checks and balances are built into the process, most notably in the assurances required by financiers, that poorly considered projects are unlikely to go forward. And such assurances are likely to be founded on revenue projections based on long-term heat purchase contracts from blue-chip customers--public buildings, major institutions such as hospitals, public housing, and substantial, stable industries. Marginal companies, or those which a city is looking to attract, will probably not be anchors of a startup system.

The irony here is that communities and their political leaders must make decisions now, based on uncertain future conditions. A district heating and cooling system, particularly one entailing some public financing, could have substantial community benefits, but many of those will be realized only after a project has been operating for some time and has proved its technical and financial feasibility. Such benefits should be kept in mind and planned for, according to many of the speakers, but a startup system should not be burdened with too high expectations. Think small, many speakers argued. Get a system going, but identify expansion potentials from the outset. Once it is proven to work, the marginal customers, those who stand to gain the most--and who the city most wants to serve--can follow. And the marketing

potential of DHC will be enhanced by a proven track record.

Private Sector Interest

In addition to more sophisticated presenters and audience, also in evidence at the conference was greater private sector representation. New district heating development companies are being formed, small ones are being expanded from single-city owners to multi-city service providers, and some are being taken over by major industrial firms. Growing private sector interest in ownership and operation may further portend that DHC is turning a corner. It's not only a good thing for cities, but it can be a money maker as well.

A Few Cautions

Public and private experience brings with it cautions for those about to get started. Bringing a project from an idea to a reality remains a complex endeavor, with additional complications added for cogeneration projects, for those serving multiple and diverse customers, and those requiring construction of new heating plants, and for those using waste as a fuel. Institutional and management complexities abound, requiring seasoned managers to negotiate. Consonant with the "think small" message that typified many of the presentations was the notion that the number of participants should be limited at early stages. Assessment work groups continue to earn support, but those that are relatively small, limited largely to those most likely to be direct participants--senior public officials, major customers, heat suppliers, financiers--seem to be most favored. A broader service area requires broader participation.

Need for Marketing

Marketing issues, too, came in for special attention. Projects do not sell themselves; the public must be educated about the benefits of district heating and cooling, a point emphasized by keynote speaker David Meeker. Meeker and others referred to a recent publication as a good educational tool: *A Statement of Priorities in District and Cooling/Community Energy Systems* by The National Coordinating Group on District Heating and Cooling/Community Energy Systems (Washington: American Public Power Association, June 1985).

Financial benefits evident to developers must be proven to prospective customers with well thought out and presented analyses. And for newly-developing projects, synchronizing DHC construction plans with customer construction plans is essential. Assurances must be given that the heat will be available the day the building opens. Finally, states can help in both consumer education and in giving technical support, as is occurring in several states now.

These are just some of the themes and messages evident from this fourth conference. The event continues to be an annual benchmark drawing together the full range of participants, technicians, developers, mayors and other public officials, the legal and financial community, consultants, equipment suppliers, and more, this year in even greater numbers than before. More than 220 people attended, about 50 more than the previous year.

This report follows the same format as last year's. Each session is reported separately and each speaker's remarks are summarized. Because the same speaker may have appeared more than once, or there were different speakers from the same city, an index of cities and sessions appears on page 57 for those readers wanting to know about particular cities.

Principal conference organizer was Wyndham Clarke, deputy director of the Energy Division in HUD's Office of Energy and Environment. He was assisted by Energy Division staff members Andrew Euston and Bernard Manheimer, under the overall direction of division director, Robert Groberg. Also assisting were several staff members of DOE's Buildings Energy Research and Development Division, especially Jay Holmes and Floyd Collins.

Welcome and Purpose

This opening session was moderated by Wyndham Clarke, deputy director of HUD's Energy Division and chief organizer of this conference. He noted the growing interest in district heating and cooling as reflected by the growing attendance at these annual meetings and pointed to the unique relationship that has developed between HUD and DOE in the area of district heating and cooling.

Echoing these sentiments was John Millhone, director of DOE's Office of Buildings and Community Systems, responsible for the Department's DHC activities. DOE's interest in DHC, he pointed out, goes far beyond its great energy-savings potential. It can create and retain jobs, strengthen cities' infrastructure, and improve environmental quality--all of which are important ingredients in the growth and redevelopment of cities. The potential role of district heating and cooling in low-income areas is especially great, he said.

Janice Golec, HUD's recently-appointed acting deputy assistant secretary for Program Development explained that her role includes oversight of the Department's energy, environment, and related activities. Her previous position had been in the HUD secretary's office, with responsibilities in the areas of Community Planning and Development, linked closely with district heating and cooling. Golec, too, noted the growing interest in the field and the recognition, from HUD's perspective, of DHC's contribution to HUD's missions of support for city growth and development and for low- and moderate-income housing.

The final welcoming statement was given by Alfred Moran, the HUD assistant secretary with direct responsibility for Urban Development Action Grants (UDAG) and for the Community Development Block Grant Program (CDBG). He indicated that his special commitment was in forming public/private partnerships, through these and other programs, in improving the condition of cities. He brought greetings from Secretary Pierce.

Moran pointed to the success of earlier HUD- and DOE-supported district heating and cooling activities, with several projects built or underway, often with HUD dollars used to leverage private investment. In St. Paul two assisted housing projects are on the system. The Trenton system will be connecting to 14 new private structures, including a new office building, rare in that older city. The initial investment in district heating and cooling breeds new private investments, as intended, in these and other cities.

But, cautioned Moran, public funds are limited and must be used where they do the most good, in such areas as research, transfer of both hard and soft technologies, and sponsorship of conferences such as these and on energy from municipal waste. New rounds of city studies are uncertain.

Moran closed his remarks by noting that current tax conditions and falling prices of oil are unfavorable for district heating and cooling development, while falling interest rates favor such projects.

SESSION 1: DHC National Overview and Trends

The future of district heating and cooling in this country holds as much as we are willing to invest and push for, David Meeker, senior vice president with James Architects & Engineers, said in his keynote address. Citing successful projects, advantages, and needs for the industry, Meeker called on the audience to market district heating and its benefits in terms the public knows and understands in order to raise the level of consciousness in regard to district heating.

The cost of energy to local government is second only to the cost of personnel. District heating and cooling can be successful and can expand, based on this single premise, he said. "In every case I've examined, decisions are being made for district heating and cooling on the basis of having a guaranteed supply of clean, efficient fuel for a good length of time at a savings. From a city's perspective, district heating and cooling is a chance of capturing this as well as an opportunity to rebuild the city infrastructure. DHC also offers preservation of jobs, increases competition for resources and for businesses.

Meeker said that because district heating and cooling is not well known and understood, when tax legislation is passed DHC is often left out of the major capital improvement programs that receive some kind of credit. For instance, he said, when energy credits have been given, district heating and cooling equipment for the owner has not been included in legislation.

Meeker also stressed the need for research in areas such as better piping, metering systems, systems that burn other fuels effectively, and methods of using solid municipal waste and eventually, liquid municipal waste as fuels.

More research is needed on environmental issues, he said, continuing, "If we all speak firmly about the need or role of DHC in our country we may be able to deal more effectively with some of the clean air requirements so that credit can be given for some of the point sources we eliminate, particularly the consolidation of the stack materials that come from residential units.

Citing some of the success stories in the industry, Meeker discussed the following, saying:

In Baltimore, the district heating and cooling system has changed and in doing so the system has expanded, with about a 26 percent reduction in fuel costs.

Pittsburgh has become a cooperative and expanded, connecting a federal building and the headquarters for Gulf Oil. There is a new hotel in the offing for connection to the system.

The Trenton system is really three different systems operating at three different temperatures. The Trenton system provides district heating and cooling to older buildings, for industrial buildings, and for the government center.

In conclusion, Meeker said that in district heating and cooling, it hasn't all been good and there are problems ahead. The price of competing fuels continues to drop. This is a short term situation, he said, stressing that district heating and cooling is one technology that allows the cities to deal with a volatile fuel situation.

SESSION 2: Introduction to District Heating and Cooling

This session covered basic DHC information from the perspective of four cities. Two of the cities had moved rapidly through the decision-making process into system design, construction, and operation. The remaining two were somewhat further behind, although the speakers indicated optimism that their projects would be built in the near future. It is interesting to note that the two cities with functioning systems are much smaller than the other two and that both have municipal utilities operating the district heating systems. The session was moderated by Richard Kuo of the New York City Energy Office.

Progress in the development of the Provo, Utah, system was described by Garth Limburg, formerly its project director and now with Salt Lake City's Capital Planning Office. He pointed out three factors crucial to its success: 1) early, active support by the Mayor and city council; 2) incorporation of DHC objectives within the city's development strategy; and 3) the existence of a municipal utility interested in making more efficient use of its energy resources. Limburg argued that the initial assessment process should be opportunistic, i.e., the potential for building DHC systems should be institutionalized within the development process by making use of heat sources as they are identified.

The Provo assessment process began about four years ago. Provo was one of the cities in the original HUD/DOE 28-city study. Initial feasibility analysis took about one year, followed by a year and a half for preliminary and final design with financing approved and the bidding process begun about one year ago. Construction began in the summer of 1985. Operations began in January 1986. (The unique financing arrangement for the $1.5 million project was described in the report of the 1985 DHC conference.)

The heat source is the downtown coal-burning Provo City power generating plant. Steam is diverted from existing steam lines to a new building housing steam-to-hot water heat exchangers. Customers are two hospitals, a high school, a recreation center, housing for the elderly, and other nearby buildings. Pipe laying moved quickly, using 40-foot pipe lengths, with minimal disruption to traffic. Low-temperature hot water was chosen to ease later expansion.

Limburg concluded by emphasizing the need to start small and develop in phases. Define an initial service area and stay with it. But maintain contact and cordial relationships with others who express interest to promote subsequent desirable expansion. A project that starts too big may be unable to get off the ground, he concluded.

Douglas Champ of Jamestown, New York, Board of Public Utilities, drew similar conclusions from Jamestown's experience with DHC. Unlike Provo, Jamestown was turned down in its initial application for HUD/DOE assessment funds. Undaunted, and recognizing DHC's great potential as a development catalyst, the city obtained financial and technical support from the New York State Energy Research and Development Administration, which has one of the few state DHC programs.

Like Provo, Jamestown has a centrally-located, coal-fired municipal power plant that was seen as a ready source of inexpensive heat energy. With enthusiastic support from the Mayor and many private business people, the city worked to develop an initial pilot project at relatively low cost. Following a favorable preliminary assessment, NYSERDA invested an additional $350,000, matched with $100,000 of city funds, for Phase II construction design. This led to a decision to quickly construct a pilot project to test both technical and financial feasibility. Thus, for a total cost of $800,000, including some plant retrofit, the system began

operating in 1984 with service to a hospital, a factory, and two municipal garages. Early success--the hospital reported 25-30 percent energy cost savings the first year--led to a $3.5 million expansion to serve 16 other customers, with at least 10 more to follow soon. The expansion is totally financed with project revenues.

Technically, no problems occurred with converting existing building steam systems to hot water district heat through heat exchangers. Champ reports heavy reliance on European experience adapted to local conditions. The pipes have built-in leak detectors and electronic fault indicators to help assure reliability.

The reports from Chicago and New York, though no less interesting, are somewhat less dramatic. Chicago's director of Energy Management, Charles Williams, discussed his city's DHC experience from his perspective as a political scientist. He noted that the rational, comprehensive decision-making model of public administration--problems are identified, options are listed, costs, benefits, weights are applied, and maximum public benefits are determined--is rarely followed in project development. But, in fact, the Chicago DHC process has many characteristics of this approach.

The process began with a systematic identification of DHC opportunities throughout the city, in the city's continuing search for lower-cost energy to bolster its sagging industrial base. The initial reconnaissance, completed in January 1984, found some 34 possible sites. After applying such factors as industrial energy consumption, distance of source from users, available fuels, vacant sites, physical barriers, and conformance with development plans, sites were narrowed to three for further study. The city was particularly interested in using waste as a fuel, given serious landfill limitations.

Supported by a grant from the Energy Task Force of the Urban Consortium, an intensive analysis was done of the most promising site, the old Chicago Stockyards area, now an industrial park. The study looked particularly at load characteristics (daily and annual), market factors, and financing. To help with market analysis, a questionnaire was administered asking about expansion plans and interest in DH. The 41 firms responding (out of 45 surveyed) showed sufficient interest to warrant considering construction of a 1,200-1,500 tons-per-day (TPD) trash-fired steam plant.

Concurrently, a developer emerged who had been considering constructing three 150-TPD plants, totally financed with private funds, as an initial project. The city is now backing the developer, with a target opening date of 1988.

Among lessons that can be drawn from this experience are:

1. Knowledge of the market is crucial.
2. Size the system to the prospective market in order to obtain financing.
3. Consider modular incinerators to leave expansion flexibility.
4. Consider expansion plans from the outset.
5. There are real economic benefits, not so much in construction or operating jobs, but in industrial retention.
6. A DHC system can be used to attract new industries, where vacant land is available.
7. The decision-making process can, in fact, be systematic. It isn't usually, but it was in this instance.

The incentive for considering district heating in New York City comes from an interest in lowering the city's energy costs, the highest in the nation, which tends to discourage economic development. Richard Kuo, the district heating study director in the Mayor's Energy Office, reported on work in progress

in the Brooklyn Navy Yard, now a centrally-located industrial park in a depressed area. An old district heating/cogeneration system built by the Navy many years ago still exists, but electric power now is provided by Consolidated Edison.

Numerous studies over several years, initially supported by a HUD/DOE grant, have demonstrated project feasibility, but a number of factors have caused delay, primarily the city's insistence on a financing arrangement that would attract a private developer and limit the city's liability. It was also important to serve over 5,000 units of nearby public housing, badly in need of a long-term solution to a critical space heating problem.

A memorandum of understanding has been signed with a developer to build and operate the system, with financing and revenue sharing with the city. The rates, for both electricity and steam, are guaranteed to be below Con Ed's. A ruling from the State Public Service Commission will allow unregulated steam to be sold up to one mile outside the Navy Yard boundaries, for systems of up to 80 MW capacity.

The developer designated after a competitive procurement is a limited partnership of the Montenay Corporation, with participation by the Brooklyn Union Gas Co. Financing of the approximately $20 million system may hinge on receiving a UDAG* from HUD. Should the project proceed, the following benefits are expected:

1. Lower electricity costs and at least equal steam costs will maintain the viability of the industrial park, retaining its 2,000 jobs.

2. The park's management will use the lower rates as a marketing tool to attract new companies.

3. Revenue from sales will be used for Navy Yard infrastructure improvements.

4. The New York City Housing Authority will save over $500,000 in annual operating costs and $3-4 million in capital costs.

5. The $5 million private equity interest plus taxable and tax exempt debt reduces the city's exposure and is used to attract financing.

Each of the speakers pointed to the important but often-neglected state role in promoting successful projects. In addition to financial help, in some instances states can offer regulatory relief, technical assistance, direct connection to state buildings such as universities and, where appropriate, building retrofit through the use of institutional conservation funds. These areas should not be neglected in project development.

*HUD has since approved a $1.85 million UDAG application for the project.

SESSION 3: Financing DHC Systems

Of major concern to both panelists and attendees in this session were the financing implications of the Gramm-Rudman-Hollings deficit reduction law and the tax bill currently under review by the Senate. Addressing the tax uncertainty with regard to the financing of district heating projects, the presentations placed emphasis on ways to overcome difficulties that may result from new legislation. While the panelists could only speculate on the impact of what may come of the present tax reform bill, it is expected that financing for district heating projects will become more difficult than has been the case under old tax law. The bill, as passed by the House Ways and Means Committee, eliminates district heating and cooling systems from tax-exempt status. Under this restriction, district heating and cooling projects would not be eligible for accelerated depreciation or investment tax credit--benefits that have thus far been enjoyed by these projects under past regulations. In addition to addressing tax considerations, the panelists also recounted from experience other financing issues involved in the development of district heating and cooling projects.

Randall Stern, vice president of Nordic American Banking Corporation, presented a banking perspective on the financing of the Trenton district heating system. Nordic American, which has been involved in lending to the renewable energy sector for the past five years, was involved in the financing of construction loans to the leveraged lease portion of the Trenton project. Stern discussed the unusual risks associated with the transaction between lenders and project developers--risks that must be mitigated in order for the project to get financed. One unusual aspect of the Trenton project's financing structure was that the industrial revenue bondholders and parties to the leveraged lease shared in the collateral and security interests of the project. This arrangement created a lot of transaction problems because of the varying interests of the two parties in a situation wherein the lenders would have an advantage in the event of a default. The complications resulted in the assignment of numerous reserves and trustees to monitor the project.

Other unusual features of great concern to the lenders included: 1) technology-related factors such as the question of whether the piping system would be able to withstand hot water at a temperature of 200° over a long period of time; 2) the absence of a nationally recognized turnkey contractor (the joint venture of Swedish firms was not well known in this country); and 3) the developer, Cogeneration Development Corporation, that had just been formed was thinly capitalized and had no track record. Despite such drawbacks, the $32 million project was finally completed and now delivers hot water to several city and state buildings, a private hospital, and other commercial users in downtown Trenton, as well as electricity to Public Service Gas & Electric.

In summary, Stern highlighted the risks typically attached to the implementation of district heating projects. These risks include: completion and operation; technological; market; regulatory; and political--risks whose concern on the part of lenders are all ultimately related to the issue of cost containment. As a final note, Stern emphasized the importance of bringing in expert financial advisors and legal representation to ensure financable contracts and effectively deal with the numerous complexities that are often involved in financing district heating and cooling projects.

Joel Rublin, attorney with Kidder Peabody, related his experience as bond counsel for the Trenton project. In order to stay within UDAG's $20 million capital expenditure limit, the Trenton project utilized a combination of an equity leveraged lease with tax-exempt bonds.

Financing for this project proved to be quite complex, consisting of $14.1 million in bonds issued by the New Jersey Economic Development Authority, $12.5 million in leveraged equipment lease financing, a $4 million Urban Development Action Grant (UDAG), $1 million in corporate equity, and about $0.4 million in study and startup costs from DOE. In order to minimize the complexity of financing district heating and cooling projects, Rublin strongly recommended reducing as much as possible the number of parties involved in financial negotiations, taking into account legal and technological considerations, and monitoring new developments in the tax reform bill to plan ways to overcome obstacles that may arise from new tax legislation.

The development of dual projects involving resource recovery and district heating was discussed by Nancy Winkler, consultant for Public Financial Management. As financial consultant for a district heating/resource recovery project in Kent County, Michigan, Winkler pointed out that a key factor in the development of such dual projects is matching the needs of the resource recovery developer with those of the district heating developer. A resource recovery developer typically looks for: 1) a long-term contract, most likely on a take-or-pay basis and for the term of outstanding bonds; 2) a stable energy demand or commitment to take an agreed minimum amount of steam or hot water; 3) an attractive price for the refuse-fired steam; and 4) a strict termination provision that would make it difficult to back out of a contract once signed. Winkler also pointed out that a privately owned resource recovery facility is likely to be interested in cogeneration so that a good working relationship can more likely develop if the project involves a utility that owns a district heating system.

In Kent County, the district heating system, previously owned by Consumers Power, has been purchased by the county, which for years has been planning a resource recovery project that would sell refuse-fired steam to the district heating system. In the summer of 1985, Consumers Power was forced by a rate hearing held by the Michigan Public Service Commission to sell the steam system. With a number of private investors interested in purchasing the system, the county sought potential buyers from the private sector in hopes of forming a public-private partnership for a joint development of district heating and resource recovery. However, it became clear that the potential buyers were interested in continuing to burn gas, adding electric turbines for cogeneration, and clearly had no interest in resource recovery development. The county thus decided to purchase the system itself and is currently in the process of signing contracts for the sale, which is expected to be consummated by March 1986.

Financing for the $100 million resource recovery project (of which $2.25 million was used to buy the district heating system) was escrowed and closed in December 1985. The bonds were issued as variable rate industrial development bonds, structured with a letter of credit from a bank and underwritten by Shearson Lehman Brothers. Variable rate financing was strongly recommended by Winkler as an effective way of saving a substantial amount in debt service costs, especially during the construction phase of a project. However, she added that this type of financing tends to meet political resistance in municipalities and is a tool which must be used carefully. Construction of the waste-to-energy facility is expected to begin in one year. Once completed, the plant will provide steam to the district heating system and electricity to Consumers Power.

Addressing the tax reform bill, Winkler predicted that given that the bill is passed, we can expect to see a substantial decline in the number of projects granted tax-exempt status, the development of a taxable market, more public offerings of debt, and increasing opportunities for access to capital markets. She strongly urged conference participants to continue lobbying on Capitol Hill as the Senate reviews the House Ways and Means Committee's tax reform proposal.

David Sowell, U.S. Department of Housing and Urban Development official, discussed the contributions of the UDAG program to numerous urban development projects. Since 1978, UDAG has assisted in funding about 2,600 projects (including district heating projects) in over 100 cities throughout the United States, amounting to about $24 billion worth of assistance. Established to create jobs and taxes for communities by subsidizing costs as an incentive to the private sector to finance urban development projects, UDAG now faces a strong likelihood of being eliminated under the Gramm-Rudman-Hollings deficit reduction law. In Trenton, $4 million from UDAG-assisted developers of the district heating project is enticing lenders to the project. Other district heating systems that have received funds from UDAG include Provo, St. Paul, Columbus, Akron, Lawrence/Haverhill, and Springfield. Sowell ended with a hopeful note that public-private partnership in district heating can continue to exist even in the fact of new tax legislation that is likely to be unfavorable to district heating development.

SESSION 4: Marketing to Cities

This session featured three speakers with extensive backgrounds in district heating and cooling. The first two speakers were consultants with recorded success in marketing district heating systems to cities and the third was a former city planner who presented the cities' side to working with or listening to presentations made by consultants interested in developing systems in his city.

The first speaker, William Hanselman, Resource Development Associates, emphasized that there is money to be made in district heating and cooling but only if the system succeeds. This statement set the pace for the remaining presentations and discussions, with the speakers focusing on marketing a successful project. Hanselman stressed that marketing district heating is different than marketing other products or services because district heating is an enterprise that requires collective action, bringing many parties together from various groups such as utilities and state and local governments who are then required to make simultaneous decisions. This is much more difficult than when each group can make independent decisions, requiring the consultant or developer to present the project's strengths and values to each group in terms that each group can relate to.

Hanselman emphasized that there is no substitute for success. And, he added, it is important that you begin small and allow the system to grow. "If you don't sell the first Btu you will not sell the first quad. After you sell the first Btu there is hope for the first quad," he said.

The second speaker, Ishai Oliker with Burns and Roe, said that his group within the company is trying to start projects from feasibility studies, following through the construction and startup, and continuing through operation.

"The first question that arises is how to find the town for a district heating project," he explained. You can look at the population, at the utilities, and you can study what people are in government, looking at how ambitious they are and what are their goals. Is the city depressed or successful? It requires a lot of homework that nobody pays for.

District heating systems require "up-front" work. First you must find the site and then the people with whom you can work. Before making any proposals, he spends time in the city to determine if district heating will fly. Only in places where there is a good chance for success is a proposal submitted, Oliker said.

Pointing out the importance of educating the city or major customers, he said that the expense of taking public officials or "movers" to an operating system is money well spent. Where once it was necessary to take these people to Europe, now there are sites in the United States where working district heating systems can be toured.

Marketing must also be directed to customers who frequently have no ambition to get district heating. A customer in a building with a new boiler is not interested in district heating. These potential customers must be educated. Oliker explained that when you want a customer to sign up for a district heating system, you must show him how he can save money. Selling district heating to customers is a complicated subject. You must be prepared to answer questions and concerns. You must gain the confidence of potential customers. The idea of starting small is of prime importance so that the people will see that one, two or three buildings work well on the system. Once you get a small system in place, the war has probably been won.

Marketing is not limited to only the consulting engineer and the city officials; many vendors are highly qualified, knowledgable people who have had

tremendous exposure to sites. They very often can help you market. Contractors who work with you can help in marketing.

In conclusion, Oliker said, " You have to have a good concept that will work. You must be confident that the savings you promise will materialize. You have to be involved not just in pure engineering, but in announcing it as well."

The third speaker, Robert Faunce, served six years as planning director for the City of Lewiston, Maine. He is now a private consultant for CFW & Associates. As planning director he managed two district heating projects and various building retrofit projects. Faunce provided a balanced approach to marketing, representing a city that has been exposed to marketing tactics from many consultants and developers in various projects. He stated that in his role with the city he often wished that marketing persons had done their homework. An important fact frequently overlooked by marketers is that the Interstate Commerce Commission has no control over regulations within the states. Consequently, planning and constructing district heating and shared energy systems in Maine are far different than planning and constructing a similar system in New Hampshire, Vermont, or other states. Taxes influence the projects and vary depending on the types of systems.

A developer must know the rules of the game in the state in which he wants to work, Faunce continued. A developer can only have credibility if he knows the regulations, rate settings, and the local public utility company's position in regard to PURPA and wheeling to other states. A developer must know about the Department of Environmental Protection or Environmental Quality or that type of bureau. A developer must know answers to the following questions: What is the bureau's position in regard to how different fuel types are categorized? How much waste can you use or can you use any as fuel stock. Do you need a special license? What are site laws or air laws? What are the regulations regarding cooling water, ash, etc.?

Faunce concluded that these answers are not all that difficult to find. A good utility attorney can get 75% of this information, giving a project a lot of credibility. The system is half sold if these questions can be answered.

The moderator, Richard Davis, Columbus, Ohio, asked speakers to cite examples where economic development has been a significant achievement of a district heating project. Hanselman responded that economic development can be seen across the board in district heating, citing Rochester and Baltimore. He added that economic development is not always an issue that people consider important. District heating is a collective enterprise, he said. A customer isn't particularly concerned with economic development. However, a city is. Therefore, you have to present the project in terms appropriate to your respective audience.

SESSION 5: The Federal Perspective of District Heating and Cooling

The roles HUD and DOE have had in promoting district heating and cooling, and the advances district heating and cooling has made in the U.S. were outlined by two high-level officials from the two agencies. Both acknowledged the continuing levels of interest in the development of district heating and cooling systems.

Janice Golec, acting deputy assistant secretary for program development, HUD, opened her discussion saying that today district heating and cooling has moved beyond a market consisting of institutional and military base systems to a renewed interest in community systems. Hud has become attracted to the advantages of hot water systems while recognizing that there will continue to be a demand for systems that can deliver steam. Both industrial processes and many older commercial and residential buildings will still be more economically served by steam, but the shift to hot water greatly expands the cost effectiveness of creating newer DHC systems -- systems which one day may be truly citywide in their delivery of lower cost services.

The technologies of this kind of investment have been around for nearly a century, Golec said. We are here these two days to exchange information about a relatively new story. It began about a decade ago, in Trenton, New Jersey, when Mayor Arthur Holland's community development director undertook a DOE-funded study to site an "integrated community energy system" facility there. That smaller city had to overcome major institutional and financial hurdles in a process that took over half a decade just to fix on a viable, privately owned and operated approach. That work has paid off handsomely for the city, and the farsighted mayor, who still holds office today. Trenton is now able to enjoy the fruits of a tested, stable and significantly expanding DHC system.

As was the case for Trenton, Golec continued, HUD has found these initiatives take local government time, and they call for local community development front-end expenditures in most instances, if they are to get somewhere. In fact, from a deal-making standpoint, there is a kinship between local urban development action grant projects and this HUD-encouraged newer brand of district heating and cooling development. Both are projects that ultimately are financed out of private capital. They take a creative administrative effort in order to see the light of day--an effort that can result in considerable leverage, including relatively fast payback of public capital. As has UDAG, DHC development requires the public sector ability to promote a concept and hold the attention of property owners, investors and their backers while technical, design, and institutional questions are gradually resolved.

Golec explained that there is one important distinction for cities to take note of, in this year of budgetary tumult, between a UDAG-type and a DHC-type undertaking. The latter offers perhaps the highest private to public dollar leverage of any physical improvement cities can make. This can be said because, from the start, one may assume that DHC implementation--including costs for detailed design, construction specification, and contract documentation--will be financed privately. True, a lesser portion of these newer systems may benefit from municipal utility finance guarantees, but all DHC systems need to come with a supportable cash flow of customer revenues, refuse tipping fees, cogenerated power payments and other income.

Getting to the financing readiness point does cost something, and it does mean taking some risk, according to Golec. The pattern for the HUD and DOE supported local phase one and two programs, however,

indicates very roughly a ratio of one to one hundred of study costs to construction costs. This is extraordinary public dollar leverage. These study funds have often used a mix of local, state and private dollars to match the federal dollars. In any case, the leverage in the successfully implemented projects HUD has seen so far is as impressive as between public front-end expenditures and privately capitalized HUD construction investments.

Provo, Utah provides one example of the snowballing investment effect of starting a DHC system. Less than two years ago Provo committed $1.3 million to build the first leg of its system. This covered the required modifications to the power plant that was to provide the hot water as well as the piping system to carry it to a large hospital, high school, and recreation center. That system is being tested and will go into service as soon as the hospital, which is already connected, completed the modification of its internal heating system.

But the truly inspiring part of the Provo story, Golec said, is how quickly demand has grown for extending the system to other customers. Provo's City Council has already voted to approve a second bond issue which will provide $3 million to expand the system to a new 8-story bank building and the rest of the central business district. The newly elected mayor, Joe Jenkins, who wanted to attend our meeting is staying home so as to conclude agreements for a new state office building and another large development which will also be on the system, she added. The availability of stable energy prices and of reliable, no-maintenance cost heating service have been marketable assets for Provo as it seeks to secure these additional multi-million dollar private capital investments.

Of course not all projects will succeed, she said. Before these HUD and DOE collaborations some communities overspent on their initial investments. Some focused far too heavily on technical questions at the expense of securing customer and financial commitments. There is still that tendency, too, for technical consultants that are new to DHC to overdo the technical detailing work. Yet, evidence suggests that a significant point on the learning curve has been reached.

Speaking to engineering firms represented in the audience, Golec said, "If engineering firms can market new DHC efforts to new cities, they may build their clients' confidence upon your collective efforts. You can provide the living examples that may be requested as to approach, as to levels of study efforts that are justified, as to the critical need for building up a wide community base of support for DHC system marketing that will be needed."

Cities can get to the point of financial supportability by gradual increments of investment--investment that builds upon a critical path of initial cost estimates, conditional customer commitments and the like, Golec said. Some states are beginning to offer very low cost computer software for securing the initial feasibility projections needed to start the process--the states of Pennsylvania and Washington are exchanging this basic technology. In Minnesota with some funding from the Edison Electric Institute the Midwest Chapter of International District Heating and Cooling Association has a small project that has been linked through our HUD staff to test out these instruments for possible use there, she added.

"What has made our HUD and DOE collaboration the most gratifying has been the readiness of our community development agencies to take on these complex negotiations in a relatively specialized area of engineering technology. In the past five years of this federal teamwork we have seen the transformation of a discredited and sometimes failing utilities' technology into a vital and widely applicable community and economic development tool for cities," she said.

Some of the DHC technology our cities are introducing is novel enough, but the real significance of the stories to be told here lies in the administrative skill of local governments and their consultants--that is, in their packaging of these newer DHC systems. The DHC implementation process, in which cities must invest, is the same kind of process that the UDAG program had induced. However it may have come about, the philosophy of public/private partnership is absolutely central to these high-leverage DHC projects, Golec said.

Where DHC is today is a tribute to the enterprise of local government and its basic community development deal-making readiness. We believe we have seen a breakthrough here. On a national scale some real hurdles have already been overcome on the part of skeptical state and local public works people, an originally indifferent banking sector and, most critical, the hundreds of new private customers that form the DHC markets on which new projects depend, Golec concluded.

Alan J. Streb, deputy assistant secretary for Conservation and Renewable Energy, U.S. DOE, discussed some of the achievements of energy conservation over the last ten years and how district heating contributes to the potential of energy conservation in the future.

Referring to a recent article in *The Energy Daily* concerning energy demand forecasts that had been made in the height of the energy crisis Streb said that it was estimated that over the next decade and onward, beginning in 1974, national energy use would be about 116 quadrillion Btus in 1985. Later, the Federal Energy Administration estimated 103 quadrillion Btus by 1985. This number was revised to an optimistic 99 quads. That represented a use of anywhere from 20 to 30 percent increase in energy use. The results are in for 1985 and show that as a nation we used about 75 quadrillion Btus, essentially the same as we did in 1973, despite the fact that we experienced about a 30 percent growth in our economy during that same period.

There are some reasons for missing the projected increase in energy use. First, perhaps the estimates were bad to begin with, although they were pegged to our economic growth. There has been a shift to service oriented economy, and that to some extend explains the difference. Nevertheless, we have to say that conservation or energy efficiency has been a much more powerful force than anyone anticipated and has been responsible for the bulk of that savings.

Conservation has probably been responsible for the 15 quadrillion Btus that we would otherwise be using were we operating at the same efficiency today as we were just ten years ago.

The results have had significant effects on our lives. The OPEC influence has waned, and our oil prices--all of our fuel prices--have dropped in relationship to the highs of five or six years ago.

In the area of energy conservation, significant improvements are possible in the next 20 years that are probably comparable to the last ten years. Those improvements are going to rely more on technical advances and, changes in methods of operation rather than the improvements we have experienced so far.

District heating provides one of those opportunities. Even though district heating systems have declined over the last 75 years, there is significant potential in the future. Two and one half quads of that 15 quads that we might save in the next two decades could be contributed by district heating systems. In particular, DHC systems when combined with cogeneration provide a fundamental improvement in our overall energy use efficiency, but in addition, district heating offers the opportunity in an environmentally acceptable way to provide alternative fuel use to satisfy the same demand and the opportunity to move from one fuel to another as prices change.

Streb explained that the mission at DOE is to provide an adequate supply of energy at a reasonable cost. "Our policy is to foster a mixed energy system. A concentration of our overall program is not to be applied to a single energy source but to all the sources. Conservation, most importantly, is viewed as one of those energy sources. Conservation as we define it is not a departure of our normal life style, but represents using energy in more efficient ways. The strategy of the DOE program has consisted in identifying the technology and information gaps that the private sector cannot easily fill. Guidelines have been to attract private sector participation from very early stages of the program. We insist on private participation not only in actually doing the work but in financing that work. In developing new technologies we view ourselves as a vehicle to provide information in the form of the results of the work and in addition to the design tools. We work closely with our other agencies, HUD being foremost in the area of district heating."

Continuing, Streb said that specific programs to date in the area of DHC include a mathematical model development that deals with prospective locations. In 1981 DOE collaborated with HUD in the Phase I feasibility studies, a followup to the 28-city study. Results of these projects show renewed interest in district heating.

In 1985 there was a second round of solicitation for feasibility studies. As a result of that, 15 cities have been selected. Workshops have been conducted in various places in the country to bring information to parties not successful in that first or second round of solicitation for feasibility studies. There is research work that focuses on various mechanical equipment including heat meters and distribution systems, design studies are underway dealing with potential design systems for retrofitting of steam systems, and there is active participation with IEA that involves eight other countries.

There are some new initiatives in the current year. We have solicited new ideas for research to reduce system cost. We are planning another round of feasibility studies for this year.

SESSION 6: Approaches to Project Development

Strategies for developing district heating and cooling facilities including setting the initial size of the project, establishing the initial anchor loads, developing a district heating and cooling team, and ownership arrangements were subjects for discussion in this session. Speakers based their observations on projects on which they are or have been actively involved. Richard Broun, Office of Environment and Energy, HUD, served as moderator.

Addressing issues that must be faced in developing district heating and cooling systems, the first speaker, Tom Denardo, Resource Development Associates, explained that his firm is not a standard engineering firm, but also has specialists in finance, economics, business law, planning and development, and real estate, giving the company a wide range of disciplines to rely on. His company's approach to Phase I is to look for a community: 1) where there is a district heating project possibility, and 2) then to try to focus on an early start system that can grow. These early start systems mean lower capital costs initially, and demonstrate that district heating and cooling systems will work in that community. An operating system such as this means it is more than a concept; it is a project that people and customers can look at. This makes expanding the system easier in the future, Denardo said.

Discussing an early start system in Provo, Utah he said that the North Loop anchor customers were from the school district, the city and the major hospital. Planning and getting the project started involved the president of the LDS seminary and the LDS chapel and other community leaders. "We tailored this planning to the community and its need," he emphasized. Once the North Loop got in the ground, attention focused on downtown. One thing you don't want to do is run pipes through the ground in hopes that people will hook to them. However, you do have to be ready to move, he added.

In contrast, in Rochester, the Rochester Gas and Electric Company was getting out of the district heating business. In that community there was a core group of customers facing a $12 million retrofit, providing motivation to look at district heating. Step one had to be to find an owner for the system. The city and county did not want to go into the energy business, but the customers were found to be cooperative. This system was probably the fourth largest in the country and at one time had 600 customers, although it was down to 100 at that time. The key was to design a system with the core group in mind, abandoning long lines out to one or two customers, improving efficiency with new equipment.

In conclusion, he repeated, important considerations include beginning with a smaller focus, working toward early start systems, and choosing a consultant with more than just an engineering technical ability because it takes more than engineering to put a project together.

The next speaker provided another approach in developing a district heating system, using a preferred developer. Joe Superneau, head of sanitation and deputy director of public works, Springfield Massachusetts, led Springfield's Phase I and Phase II studies. Springfield decided to build a system and took a preferred developer route. The Springfield approach illustrates how a city can do the front end work and then turn the project over to a private firm.

Springfield is a community with a population of about 150,000. City funds are acquired through real estate taxes, state aid, and federal aid. During the 1960s and 70s, downtown lost 15 percent of its retail establishments. Then in the 1980s redevelopment began and people started going downtown again. In 1981 the city was awarded one of the 28 city feasibility studies. That took the city to a point where it has identified energy sources and energy customers. The city also has signed a

contract for a solid waste-to-energy facility which will generate electricity and will be equipped to cogenerate and provide steam to a district heating system. Contracts and financing are in place. The waste-to-energy system has a separate developer and the city hopes to break ground in April for construction, Superneau said.

The district heating development process was initiated by the city's request for proposals. As part of this process, the city offered to sell the district heating system, the boilers, and air conditioning equipment to the developer who could use the facility as a base to create an ongoing system. The RFP also outlined potential customers that would participate in the facility. He concluded that there are no hard and fast rules about whether the city or a developer develop a system, but that a community has to reach this decision.

John Martorella, with the Cogeneration Development Corp. of New York City, the next speaker, presented project development from a developer's view. CDC specializes in developing, owning and operating cogeneration systems. Besides developing the Trenton system that has been online for about two years, CDC has two other systems in development, with both projects "about ready to go," according to Martorella. "There are two ways to provide district heating, he said. One is to go with a central boiler system. The second and more complex way is to have a cogeneration facility as the prime mover or the central heating source. His talk concentrated on the second approach.

When looking at a system for possible development, the company considers three key areas of concern: 1) is there an acceptable utility and acceptable utility economics; 2) is there a thermal heating and cooling market and is it dense enough; and 3) is there support from the local government.

Once those concerns are satisfied, the project starts with a feasibility study and goes to a more hard core phase where the contracts are negotiated with users, utilities, governments, etc. In the latter phase, there are six key elements that must be juggled together. These are: 1) you must have a sound technical solution; 2) contracts have to be formed that everybody can live with including power purchase contract with the electric utility, thermal contracts, fuel supply contracts, and construction contracts; 3) the market potential and the load ties must be established (for the first phase of the project you want a set of customers that are large users with sustained load factors); 4) financing arrangements must be worked out; 5) recognition must be given to regulatory constraints and freedoms such as environmental constraints; and 6) economic feasibility must be established. This is where everything comes together. All previous items affect economic feasibility and all impact on the final project, he said.

Throughout the development process it is important that the developer and the host organization remain flexible in their approaches to the project. New issues will continually come up throughout the development stage. For a project to be successful both parties must remain flexible, he stressed.

There are many potential district heating and cooling projects, many opportunities for privatization, and, there is always room for new facilities to link isolated users together. District heating is a good tool if you are looking for ways for rehabilitation of older, rundown areas, Martorella concluded.

The last speaker of the session was Ronald Sundberg with Springsted Inc., a financial consulting firm in St. Paul, Minnesota, working on district heating projects. Previously he was with the State of Minnesota, running that state's district heating program where he was involved with early development stages of the St. Paul system and a number of other projects in smaller cities such as Red Wing and Bagley.

District heating is one of the more complicated projects to finance, Sundberg said, and raises some important questions. First, who puts up the money; second, what form is that money in; and finally, who is going to take the risk? You have to look at district heating as having three subsystems: first, a heat source, which may be a facility boiler or power plant or owned by private utility, the transmission or distribution system, and of course, the end users, he explained.

Behind all this, he said, is a unit of government that is interested in encouraging district heating. The unit of government has things to contribute and things it wants to get from implementation of a district heating project. The government unit can bring tax exempt financing, provide grants and loans, provide equity, assume risk, and it can set an example by converting its own facilities to district heating or solid fuel. And, of course, the benefits a government unit is looking for are economic development and lower cost energy, he said.

The role of the public financial advisor is basically to represent the financial risk of the unit of government whether the unit government is requesting the proposals that will result in a private developer or is actually going to be developing, owning and operating the facility itself. In the case of the government using its tax exempt borrowing power to increase the chances of such a facility being constructed, the risk to the government must be carefully considered.

Addressing the system economically, Sundberg said that energy must be sold at a low enough price that the end user can get a reasonable return on the money he has invested in converting his heating system to use the district heating energy. The energy also has to be sold at a price high enough so that the debt on the distribution system can be met and any financial obligations associated with the heat source can be taken care of. Financing can take the form of equity, money someone is willing to put up or risk; equity can come in three forms: 1) risk capital from the developer; 2) third party equity, someone interested primarily in tax benefits; or 3) government equity in the form of equity loans. While most district heating systems are heavily leveraged with a high proportion of debt to equity, the equity is an important component because it does allow some flexibility in economics, Sundberg explained.

When we think of debt, we think in terms of tax exempt debt. From a government standpoint, being able to sell tax exempt debt provides an interest rate that is lower because the interest is not taxable by the federal government, and in most cases is not taxable by the state government. This tax exempt debt can take the form of general obligation bonds or revenue bonds. The best mix of financing is a strong determinant of project success, Sundberg said.

Sundberg continued, saying, there are two extreme risks often taken in a project. One is project financing where a financing agent must face long-term contracts, take or pay contracts, and so-called "hell-or-high-water" contracts, where an agency must pledge to support a project no matter what. This provides a substantial benefit to the people who are going to sign a contract for heating or energy, so that they will be willing and/or able to sign a long-term contract.

The other project financing extreme is having financing that is guaranteed with full faith and credit. This can take form of full faith and credit of a city, county or a large corporation.

SESSION 7: Ownership Options

Ownership options are essentially dictated by capital formation options and economic considerations. This was the view held by session moderator William Mahlum, attorney for the St. Paul District Heating Development Company. A developer's strategy for procuring funds to develop a district heating project will largely determine the ownership mode selected. Customer expectations and willingness to participate in the project is also another important consideration. As an overview, Mahlum pointed out the different types of for-profit operations: corporations, partnerships, limited partnerships, for-profit cooperatives, and varied combinations of these. Other ownership options include municipal ownership, non-profit corporations like St. Paul, and private/public partnerships wherein some elements of a system are owned by the private sector and others are municipally owned.

Previously owned by the local utility, the Pittsburgh district heating system is now owned by a non-profit membership corporation formed by the steam customers in 1982. George Whitmer, assistant to the mayor, described the transfer of ownership which has resulted in substantial increase in the system's efficiency and reduced steam rates for its users. In operation since the early 1900s, the steam system in Pittsburgh, as in other cities, was adversely impacted in the early 1970s by 1) air pollution regulations that made it necessary to convert from coal to oil, 2) the Arab oil embargo, 3) and the utility's increased investments in nuclear power development which decreased capital invested in steam. The resulting rise in steam costs forced many customers to leave the system, raising the rates even higher.

In the late 1970s, building owners suggested that the city create an authority to take over the steam system, which would have required no commitment on their part. The city, however, was clearly not interested in investing capital into the system. After four years of examining ownership alternatives, during which time the utility had begun preparing for abandonment of the system, a non-profit membership corporation was formed. It is presently governed by a board composed of system customers that meets once a month and sets an annual budget from which rates are projected. Bonds ($7 million) were issued to rehabilitate the system which needed new boilers, had no condensate return, and was operating at well below 40 percent efficiency. The utility agreed to remove the old boilers and leased one of their buildings with three ten-year leases at a rate of $1 per lease. The upgraded system presently sells up to 78 percent of the steam that is generated. The board is looking into other sources from which gas can be purchased at lower rates than those charged by the utility in order to further reduce steam costs.

Garth Limburg, formerly with the City of Provo and currently with Salt Lake City, discussed the attractiveness of Provo's publicly owned municipal utility, which is in the process of constructing a district heating system. A major advantage of public ownership is in the area of project financing, namely the lower bonding rates that can be realized under municipal auspices. Limburg also discussed the institutional structure of the publicly owned utility, which under Utah law is regulated not by the Public Service Commission but by the city council that has final approval over any rate changes.

Steam customers will include public and residential buildings in the immediate vicinity of the power plant, with later expansion to include commercial customers in Provo's central business district. The city remains strongly in favor of district heating development as an economic development strategy that effectively creates jobs in the community.

In Bucks County, Pennsylvania, the development of a district heating system to be owned and operated by the county is currently awaiting approval. Kenneth Kugel, director of the Bucks County Planning Commission, described the two-phased project: Phase I - development of an oil-fired pilot project to provide hot water service to 4-5 large facilities in the Neshaminy Many Center, a 370-acre multipurpose county site; buildings to be serviced include a nursing home, a youth rehabilitation center, a senior citizen housing complex, and a new prison; Phase II - construction of a 100 TPD waste-to-energy facility that would provide refuse-fired energy for the district heating system and allow it to expand to serve other buildings in the surrounding area which shows promising potential for commercial growth.

The first phase of the project is expected to start operating in late 1986, by which time a final decision will be made as to whether or not to implement the 100-TPD resource recovery project. The county will administer, own, and operate the project and county facilities will be the system's sole customers during the project's first phase. Under the most ideal conditions, the county expects payback on the pilot project in two years and a 2-3 year payback on the resource recovery facility.

Carl Avers, president of Youngstown Thermal Corporation, presented a private owner's perspective on district heating development. The steam systems in Youngstown, Baltimore, and St. Louis, all presently owned by Thermal, were formerly owned by utilities who opted for either abandonment or divestment. In Baltimore and Youngstown, the utilities chose to divest and sell their steam systems to Thermal, which is working to restore and maximize system efficiency and is actively engaged in marketing steam.

The St. Louis district heating system is owned by a public/private partnership; Thermal owns the steam plant and Bi-State Development Agency (an interstate authority responsible for regional development projects in the St. Louis metropolitan area), owns the distribution lines. Under this arrangement, Thermal provided the equity to purchase the system and bears all risk and responsibility for operation and maintenance of the system. The advantage of this dual ownership is the deregulation of the service made possible by the system's partial ownership by a public entity. Under the previous ownership by Union Electric Company, the system was regulated by the Public Service Commission, which imposed substantial rate increases, causing customers to leave the system and steam revenues to drop significantly. Thermal and Bi-State are now aggressively marketing the system and plans for expansion are being made in conjunction with the development of a resource recovery facility that will provide the system with refuse-fired steam.

In discussing ownership modes in Baltimore, Youngstown, and St. Louis, Avers pointed to the site-specific nature of district heating projects, emphasizing customer needs and preferences as the major determining factor in economic and technology-related decisions. He also stressed the use of coal and refuse as favorable fuels for district heating systems because of their stable prices in comparison to oil and gas.

SESSION 8: Finding A "Do-able" Project

District heating assessments are conducted to determine whether a city has a "do-able" project, i.e., one that is likely to be built. But what is "do-ability?" What tests have to be met, even in the early assessment stage, to decide whether it is reasonable to proceed to the next and more expensive steps of detailed analysis and financing? This session dealt with definitions of "do-ability," and their application to actual conditions. It elicited interesting and sometimes conflicting comments from the speakers, highlighting the often-repeated point that there are no simple answers.

Moderator Andrew Euston of HUD offered an opening set of criteria, with the panelists using this as a point of departure. Euston suggested:

- financial feasibility,
- political support,
- technical feasibility, and
- community acceptance

as the four principal "do-ability" tests.

The first speaker, Kevin Brown of Cogeneration Development Corporation, New York-based developers of projects in Trenton, Atlantic City, and Nassau County, began by noting that the DHC development process is complex, intricate, and time consuming. No one should enter the process without the skills and commitment to stay with it for an extended period. From a developer's perspective, the following issues determine project viability:

1. Density of heat load. Projects need "anchor" customers with sufficient heat demand who are credit worthy and willing to sign long-term contracts. In Trenton, the government buildings that signed on early were crucial to the project's success.
2. Diversity. Customers who look to the DHC system to supply not only space heating but also process steam and absorption chilling, improve chances of success because they allow for variations in economic conditions, temporary loss of one or more customers through such things as work stoppages, and a more balanced load.
3. Cooperation and support of elected officials. Such support can ease the often complicated and time consuming process of site selection, permitting, lease negotiating, tax payments, etc., which can affect construction schedules and revenue flows.
4. Utility support and participation, particularly in the case of cogeneration projects.
5. A team with a "span of effectiveness," a breadth of knowledge of the process ad system alternatives.
6. Maintaining control of construction costs--overruns can kill a project.

The next speaker, Barry Shance of HML Construction Engineers, Arlington, Virginia, took a somewhat different tack, emphasizing the uniqueness of local situations. Relying on his extensive Danish experience, he recommended a "think small," approach; do not try to implement a large startup system that burdens a project with large front-end costs. Rather, develop incrementally and look for a breakeven point within one year of operations. Consider starting with a temporary plant or available surplus heat sources, relying on more permanent sources after a shakedown period.

He emphasized three "don'ts:"

1. Don't foreclose possibilities; keep options open.

2. Don't limit options only to highest density locations. Sometimes a shorter transmission distance is offset by high costs of laying pipe across existing utility lines or major streets.

3. Don't get hung up on downtown projects. Some are not sufficiently dense. Recently-built buildings may operate efficiently and not have much heat demand.

Overall, he said, it is useful to collect substantial local data on ownership, regulations, economic, and governmental conditions. Sometimes possible projects emerge serendipitously from these data.

A contrasting point of view was offered by William Hanselman, president of Resource Development Associates of Dayton, Ohio, and consultant to the cities of Baltimore, Provo, and Rochester. Hanselman argued that projects are not found in data, but that they are created in sometimes unexpected places through careful legwork and analysis by a trained team of professionals in diverse fields. His approach to determining project feasibility relies more on organizational/management issues than on technical ones.

Commitment may be most important. Members of the team must have something at stake, even if only their reputations. And, even going into the process, projects should not be overburdened with too many objectives and e expected to provide too many benefits. The most important thing is to quickly zero in on a project that appears to be feasible, and evaluate engineering, ownership, siting, marketing, and financial options. The assessment process, he feels, should be focused rather than broad; there rarely is enough money to do a systematic reconnaissance.

In summary, he defines a "do-able" project as one that gets done. If it works, its span of benefits can be broadened later. Some apparently marginal projects have succeeded this way while others that looked good on paper are still pending because too many demands have been made of them by too many interests. Bad projects, Hanselman feels, rarely get built because there are too many checks and balances in the system, especially the need to obtain financing.

The final speaker offered a unique perspective, that of a state official. Gordon Bloomquist of the Washington Sate Energy Office described the unique position of Western states. Their electricity rates are relatively low so, while they are interested in municipal district heating, they have little interest in cogeneration. The state role then is to promote and give incentives to local district heating projects. In Washington, the state has developed models that help localities screen out poor projects. For prospective geothermal projects (his area of specialty), the screening process considers flow, temperature, ownership of the resource, and other factors.

He discussed the HEATPLAN computer model which can provide heat density maps on a building or block basis to help determine whether there is sufficient justification to proceed with more in-depth analysis.

Bloomquist's view is that providing such technical assistance is an appropriate state role, one which helps communities decide whether to hire a consultant for a more comprehensive assessment.

SESSION 9: Project Management

This session provided a short course on the role of the project manager in developing a DHC system, from the perspective of three experienced managers. Moderator Jay Holmes of DOE set the tone for the presentations by defining the essential ingredients of good management, regardless of the project, as establishing and maintaining clear 1) performance requirements, 2) schedules, and 3) budgets and 4) holding individuals accountable.

The speakers discussed their management approaches, as derived from the experiences in their cities.

Pieter Dekker of Holland, Michigan, noted how his outlook toward DHC project management is shaped by his position as Electric Department Manager of Holland's Board of Public Works (BPW). Holland is a city of 40,000 people on the eastern shore of Lake Michigan. It operates its own centrally-located, coal-fired power plant. Although the city fathers had the foresight to include district heating in the mandate of the BPW, no DHC systems exist in the city. The HUD/DOE assessment program was seen as an opportunity to explore possibilities, using the power plant as the heat source.

Under Dekker's direction, BPW hired a consultant to prepare the proposal and subsequently to do the assessment. The development team consisted of BPW staff, members of the assessment work group (AWG) (required by the contract), and the consultant. In Dekker's view, there are important ingredients to managing an AWG. It should include probable anchor customers. Members should know what the study's end product will be and the steps to get there. The complete set of meetings should be scheduled at the beginning with preliminary agendas, to facilitate productive work. Meetings should be used for decisions and to give staff and consultants instructions for succeeding work, rather than just to share information.

The project manager rather than the consultant should run the project. Regular progress reports should be built into the schedule, and the project manager should know in advance what the consultant will present at AWG meetings.

Concurring in views expressed by others at this conference, Dekker urged that projects be kept small from the outset. Although there are pressures on DHC projects to be used to help revitalize declining areas, in early stages such benefits are limited. What is most important is to get something going with anchor customers, then expand to other customers. Small projects require less marketing and are more likely to get built. Only after Phase I was completed did Holland seek broad public support.

This approach seems likely to succeed in Holland, which is expected to begin construction this year.

Rita Norton, manager of Energy Systems in the San Jose, California, Mayor's office, agreed with Holmes' definition of project management. In contrast to Holland, San Jose has no municipal utility and started its energy management program by thinking small, appealing to the concept of energy self-sufficiency. DHC is a substantial expansion from earlier energy programs whose benefits are seen as 1) an incentive to locate in the downtown area, 2) an economic multiplier effect, and 3) a pilot project to help develop exportable technologies.

The DHC project itself will initially serve a convention center and two hotels now under construction, with probable expansion into nearby commercial areas.

From her experience, Norton derived a lengthy list of management observations:

1. Be entrepreneurial and persistent, especially with innovative projects.

2. Be sure that project objectives support broader city objectives.

3. Be visible; obtain top-level support and access to leadership.

4. Obtain a clear project mandate, which can be referred to when decisions are needed.

5. The project manager must have budgetary control during the study period.

6. Communicate frequently with key people within and outside the project.

7. Keep meetings focused.

8. Stay on top of the critical path of other projects with which DHC must link, such as construction plans of buildings to be served.

9. Obtain political commitment and participation; politicians needs to know why DHC is important.

10. Identify the risks up front and how they can be mitigated.

11. Keep options open; look at alternatives.

12. Involve key people in the project by taking tours.

13. Get commitments and make sure they are kept.

14. Keep on top of consultant work. Different consultants for technical and economic analyses may provide balance and diversity.

15. Document meeting results.

16. Build in slippage; allow plenty of time for negotiations with customers and utilities and for unforeseen events.

In response to a question, Norton opined that a formal AWG may not be necessary so long as key people are actively involved.

The final speaker was Robert Faunce, now consulting with CFW Associates in Brunswick, Maine, and formerly planning director in Lewiston, Maine. He spoke from his experience in managing the feasibility assessment of Lewiston's cogeneration project.

A cogeneration project makes a DHC project much more complex, with a need to understand utility negotiations, regulatory issues, avoided cost rates, state energy policies, and many other factors. The burden for keeping up with these and handling often delicate interactions falls on the project manager. Although the consultant will provide the expertise to deal with such questions as siting, environmental standards, ownership options, wheeling, etc., the manager must be in a position to evaluate and act on results.

The schedule of required permits and other filings should be built into the schedule; the consultant should prepare a detailed project schedule, even for work outside its scope of services, preferably using a critical path method (CPM) approach.

Faunce added his views on the composition and role of the AWG. While agreeing with others that it should be kept small at the assessment phase and consist largely of prospective customers, he cautioned against underestimating the members' knowledge of engineering and finance and their commitment to the project, in their own self interest. At the same time, the project director should not overestimate their knowledge of district heating, which may mean that some education is needed. The workload, however, should be kept down; they are part-time on the AWG and have other full-time jobs or businesses to run.

In Lewiston, a special position was created that might work in other places, that of a technical consultant to work directly with the project manager in interpreting the work of the consultant to him and to the AWG. Although not directly responsible for work products, this special consultant checked on the principal

consultant's work and evaluated its technical analysis and results. Such a function may well serve other communities in which the project manager is relatively unfamiliar with the technical intricacies of DHC.

Overall, these experienced managers presented a host of tips on how to effectively manage the complex technical and administrative work in a DHC assessment. It seems clear that the discipline of the project manager is less important than management ability, along with some knowledge of public administration, planning, finance, and the development process. An engineering background is not crucial, but an ability to understand and interpret engineering studies is.

SESSION 10: Marketing to Customers

Emphasis on marketing as a fundamental key to the success of district heating was the focus of this panel discussion. As moderator Monica Krautbauer of St. Paul District Heating Development Company pointed out, bringing in and retaining customers is the single most important aspect of maintaining business for any steam system. Participants on the panel addressed the following basic marketing issues: market characteristics in each community; marketing vehicles utilized; marketing hurdles that must be overcome; and the marketing advantages and strengths of their respective systems.

Stuart Temple, vice president and general manager of operations for Thermal Resources of Baltimore (Thermal), discussed the marketing approaches utilized by Baltimore Thermal since it purchased the district heating system from Baltimore Gas & Electric (BG&E) in February 1985. A key to the success of the steam system's new owners has been its emphasis on stabilizing steam rates. Thermal has been working to realize this objective by converting to solid waste (a more stable fuel than oil or gas) and through its continuous efforts to attract more customers. From the outset, as negotiations were proceeding with BG&E for the purchase of the steam system, Thermal worked toward establishing favorable relations with the system's customers, inviting them in for discussions prior to the transfer of ownership. The customers were assured of continued reliable service and that Thermal was negotiating with BG&E on their behalf. Thermal's strategy to increase public awareness of district heating and its advantages included involvement with the city on all levels and urging Thermal employees to seek opportunities to speak in public to promote district heating in the community.

A public education strategy to attract new customers has also been utilized in San Francisco, according to Richard Mayer, manager of the San Francisco Steam District Heating System. Owned by Pacific Gas & Electric, the system has focused its education efforts on architects and engineers, since they are involved in planning for in-house boilers for buildings in the community. It is they who must be convinced of the energy efficiency of district heating as well as the advantages of increased space availability and savings in labor and capital costs that connecting to a steam system will allow. Clearly, the biggest selling point has been the convenience and economic advantages that district heating can provide to customers.

Mayer pointed out that a problem often encountered in their marketing efforts has been finding the right contact when looking at a prospective customer. In light of this problem, Mayer emphasized the importance of determining at the outset who the appropriate person is to talk to about the advantages of connecting to a district heating system.

In Minneapolis, Minnesota, the district heating system is being constructed as a new hot water system. Jack Kattner, with the Minneapolis Energy Center, discussed the marketing efforts that are currently underway for the new system. Kattner stressed the importance of educating not only the architects and engineers but also the building owners themselves about district heating. He also pointed out the advantage of using solid waste as a low cost fuel and that when negotiating with resource recovery developers, district heating representatives must speak on behalf of their customers, since any savings to a district heating system will be translated into savings for customers.

Along with efforts to market the new hot water system, Minneapolis is also continuing to develop its steam market; it is thought that eventually the city may be able to connect the two systems.

An interesting marketing perspective was provided by Kevin Fisher, an engineer with Geothermal District Heating Systems in San Bernardino County. Marketing geothermal energy in San Bernardino County, California, is somewhat different than that of other steam systems. Unlike most other district heating systems, a geothermal system does not have to burn any fuel for energy; it is taken right out of the ground and is essentially free energy. Since the water is heated at no cost, the system is able to provide hot water to its customers at a guaranteed price of 75 percent that of natural gas. The system consists of two wells and 34,000 feet of insulated piping and pumps 1,000-2,000 gallons of hot water per minute.

Most of the buildings in San Bernardino are fairly old and are constructed to receive steam so that the systems must be converted to accept hot water. This has raised engineering problems and concern regarding retrofit costs.

In order to convince building engineers of the feasibility of space heating from hot water, a pilot project was set up to demonstrate how this can work. For the past two years, the pilot system has been providing heat to a number of stores and office buildings, a county blood bank, and an animal shelter. This has proved quite successful in convincing potential customers of the feasibility and practicality of the geothermal hot water system.

Effort to attract customers has also included an information program for engineers and architects n the area. Another marketing strategy used is the unique financing approach, which includes an offer to customers to finance the project at an interest rate of 9.85 percent with a $4,000 grant for connecting to the system. An alternate financing scheme offered to the customer is third-party financing, wherein an engineering firm is brought in to do the entire design and guarantees the savings with an insurance bond. Customers presently being connected to the system include the City Hall, Convention Center, County jail, a retirement plaza, and others. It is anticipated that by next year the system will be serving approximately 65-70 customers.

SESSION 11: Design Tradeoffs/Technology

Speakers engaged in a number of projects as consulting engineers or with architecture/engineering firms discussed the opportunities that are available to other firms interested in district heating. Wyndham Clarke, District Heating Program Manager, HUD, moderator of the session, explained that this session was intended to give some feeling that "there is more than one way to skin a cat" technically. "Everything does not have to be done by the utility handbook as you approach the design of a system and as you try to find early start systems. There are acceptable things other than this that will produce a safe, sound, financially viable system that you can hang your engineer reputation on."

Speakers gave their perspectives on some of their projects that illustrate this point. All agreed that to design a system that is both economically efficient and that meets the customer needs, tradeoffs are necessary. And, all cited the lack of domestically produced equipment to use in construction as a major problem.

The first speaker was Lief Bergquist with Cogeneration Development Corp. and chief engineer on the Trenton project. He also is working with CDC on two other projects, Atlantic City and Nassau County. Bergquist cited the Trenton experience, pointing out the need to make numerous judgments of how to step down from the ideal low temperature, easily operable, highly efficient system. The company looked at the development stage of the Trenton system. The first step was try to arrange a hydronic system that would give virtually unlimited geographic spread. This enabled the proper thermal loads to be tied into the plant. The next step was to get the proper load factor tied into it. Then the first and most significant tradeoff was made in the system--increasing the energy levels--allowing buildings to be tied in that otherwise would be lost. Having steam available opened other buildings, including a state prison where sections are so old that they are rated as historic landmarks. It was a building that could not be retrofitted. While experience indicated it was wrong to take the high temperature approach, this tradeoff had to be made or the project would not be done at all.

Then, the problems we had created by going to a high temperature system had to be solved. This was done through a hot water distribution system distributing 400° water to steam customers, and by having several distribution systems at different temperature levels.

Trenton was a compromise between what was optimal from an engineering viewpoint and was actually "do-able."

Bergquist also emphasized that engineers should work toward getting more efficient and cost effective heating equipment to use in district heating construction and retrofitting. The district heating market in the U.S. is not big enough to promote the development of equipment manufacturing, he said. We are confined to live with what was produced for the processing industry in general. The fact that we don't have proper equipment is hampering district heating development, with technology needing to be imported from Europe.

In Trenton the system was customized to fit the existing buildings. This has not been the case in Jamestown and St. Paul where the buildings were fitted into the system. Neither decision is wrong. But, every system has to be tailor-made to fit the customer. And, neither of the two routes is the right route. Perhaps the best is to do a little bit of both, Bergquist said.

We believe it is better to get out the crowbars and hammers and barbed wire and build a project than it is to do a fancy study that just sits there, Bergquist concluded.

Floyd Hasselriis, consulting engineer with Gershman, Brickner & Bratton, Inc., concurred with Bergquist, saying that in any type of district heating planning there will be tradeoffs. Relating to his experience with the U.S. Air Force and later in Japan, he said that lack of equipment is a problem in the states that does not exist in Europe because there the manufacturer also designs the system. Our manufacturing structure does not allow the system to mass produce equipment to support the industry, he said.

Today, major corporations are building, owning, and operating systems. While this hasn't filtered down to district heating to a large extent, it has begun in waste-to-energy facilities.

While working in Japan, Hasselriis designed a basic one-pipe system for a Japanese district heating system to serve a high-rise complex and provided them with a system that was minimum cost. This was important because it was a co-op. This innovation allowed hot water to be put into housing for a reasonable amount of the rent dollar. This is an example of a much cheaper way of doing things. This can also be used in a retrofit system applicable to row housing, Hasselriis said.

The existing institutions are less important than the mix of users. The political prospects of the project may be determined by whether or not public or private housing is served. District heating will not work if the cost of conversions is outrageous. We have to find better and less expensive ways of retrofitting and building, Hasselriis concluded.

Ishai Oliker of Burns and Roe pointed out that designing a district heating system requires not just safety and reliability but also reasonable cost over 30 or more year life. If a viable system cannot be designed in the first place, there is no good product to market. He suggested that the following principles generally apply:

1. Burn low cost fuel (coal, refuse, etc.).
2. Use cogeneration.
3. Use as low temperature as possible.
4. Use cooling tower condensers.
5. In retrofitting old buildings, look at all components.

In Jamestown's first phase the plant's existing heat exchanger was used. Once in operation, the next step involved converting the turbines to cogeneration. In some cases electricity is a low cost energy. Perhaps heat pumps can be the best solution. The advantage of district heating hot water systems is their unlimited design opportunities. As soon as the hot water loop is built, any source of heat can be fed into it. The level of temperature will be determined by the needs of the customers, in turn needing a piping decision. The number one problem is protecting the underground piping system from underground water. One of the best ways is to use heavy-wall plastic casing. Other types of insulation cost more for labor and installation.

SESSION 12: Cities' Presentations - Phase I Projects

Representatives from four cities involved in Phase I studies, Columbus, Ohio; Vineland, New Jersey; Lincoln, Nebraska; and Crosswell, Michigan summed up their experiences during this session. The cities ranged in size from 600,000 to 2,000 population, providing a wide range of interests and possibilities for district heating projects. Floyd Collins, Office of Buildings and Community Systems, U.S. Department of Energy, moderated the session.

The first of the speakers, Steven McClary, joined Columbus, Ohio, in 1973 and is planning administrator. With him assisting in making the presentation was Richard Davis, project manager. McClary focused his discussion on the use of district heating as a development incentive. He described Columbus as a city with a population of about 600,000 persons, a white-collar city with a work force engaged in governmental work, education, and retail, with a service-oriented economy. Columbus has grown from 50 square miles to 180 square miles in about 35 years. In the mid-1970s Columbus became energy conscious and in 1977 voters approved a $118 million bond issue to construct a waste-burning power plant to generate electricity to light streets and to power the municipal buildings.

In 1981 Columbus was one of the 28 cities to receive a grant from HUD to study the potentials of district heating in the city. In late 1982 Columbus entered into an agreement with the Danish government which brought consultant expertise and planning to Columbus. Since then, the city has concentrated on how to turn those plans into reality.

McClary said that Columbus has found several areas where there are both energy benefits as well as development benefits. These include a new trash burning plant that generates electricity. It's estimated that the wasted heat could be used to heat the county work house and perhaps a new greenhouse development. In the long-term, a district heating system could also be hooked up to the downtown area four miles away.

Principles guiding Columbus' approach to district heating include the following:

1. A short term startup, with a system that can demonstrate its success quickly.
2. A system that can be built incrementally.
3. A location that makes use of existing heat sources where possible, using waste heat that may be available.
4. A system that is competitive with alternative fuels.
5. A situation that is attractive to private developers.
6. A system that will be privately owned and operated.

McClary pointed out that there is a unique opportunity in Columbus, with a riverfront development site just across the river from the downtown area. This is enhanced with the abandoned penitentiary and a high school, both prime redevelopment sites. Adjacent to those buildings is another site housing a municipal health building that will be relocated to another site. This tremendous redevelopment area also includes a former municipal electric plant, closed when the trash burning plant came on line.

It was determined that the electric plant could be brought back on line and be a heating source for a riverfront district heating system. In the short term, the city is looking for a system that would link the municipal electric plant with a restaurant complex that is going to be built, extending across the river to connect future buildings

and city and county buildings. The penitentiary and the high school site could also be connected, McClary said.

Concluding, McClary said that in Columbus district heating is considered one of several tools for redevelopment. These tools would serve to shift development interest back from the suburbs to the inner city.

Vineland, New Jersey, with a population of 47,000 people was represented by Raymond Lawson. Lawson discussed the feasibility study and two proposals that the city is evaluating. The first is for a full district heating system and the other is for a pilot project.

Vineland is the only municipality in New Jersey that owns its own generating plant. The city also has an old steam district heating system with one customer.

Work is underway by a consulting firm to analyze possible modifications to the plant to adapt it to district heating. A preliminary review of the city shows as much as 30 megawatts of thermal load within a mile and a half of the plant.

Lawson explained that the city is looking at a small pilot plant that would prove the benefit of district heating. The utility currently has a 30-year old boiler. Instead of replacing it, it could be a key to starting a district heating system, serving the city's steam customer and another proposed hot water customer. In this same area, Lawson said, there are redevelopment and housing authority properties that could tie on at some later point. This project would demonstrate the technology and economics of hot water district heating.

While the city of Vineland still has some unresolved issues concerning economics of the system, ownership, backup sources, and financing, this is basically the way the city is going, Lawson concluded.

Donald Killeen, city property manager for the City of Lincoln, Nebraska, discussed the extensive redevelopment in Lincoln, including replacing blighted areas with new shopping areas. He described Haymarket Square, a preserved area. The city has looked at several heat sources and currently is evaluating waste water effluent.

Killeen said that the economic development aspect of a district heating system has been a big attraction. He also believes district heating would benefit Lincoln, providing an opportunity for the city to use idle resources.

However, he said that in Lincoln there is no energy crisis. With reasonable coal prices and with rates set strictly on the basis of cost and service, there is no push for a district heating system.

Crosswell, Michigan, a town with a population of 2,000 people, was represented by the city district heating planning manager and city engineer, Dale Soumis. Soumis explained that Crosswell is primarily a rural community with agriculture as a major industry producing sugar, pickles, and automobile plastics. The town owns its own electric utility.

Some of the problems Crosswell faces are: 1) no place for waste disposal; 2) rapidly rising energy costs; 3) a failing agricultural industry; and 4) decreasing public budget and increased demand for services.

Soumis said that before the town received information on the DOE district heating program, it had come to the conclusion that district heating had potential for Crosswell. The study looks at a multi-fuel system that uses solid waste as a primary fuel, supplemented with wood chips and high sulphur coal. The town also wants to look at steam generation. A multi-fuel system would generate steam for the sugar plant and the pickle company and hot water would then be sent to other customers. Low cost steam would reduce costs for the existing plants.

However, Soumis continued, a number of problems were found. First, the

sugar plant generates 50% of its own power and the city can't compete with their energy costs. Second, all the steam used in the pickle plant must be FDA-approved, and it uses 95 percent of the steam it generates. Third, the school building's heat plant was built in 1945 and is very inefficient. Finally, the most modern building is all electric. No matter how it was analyzed, it was impossible to design a system with a balanced load or a full load.

The city is now considering putting in a gas turbine, coupling that with a steam boiler. That would allow transmission of FDA-approved steam to the pickle company and hot water to the school system. Another possible project is a German company coming in and merchandising European canned products . This company is intrigued that the town is going into district heating since that is what they are used to in Germany, he concluded.

SESSION 13: Economic Impacts of DHC Systems

In this session, presentations went beyond discussions of the DHC systems themselves, to the effects of DHC on their communities. District heating, of course, is not an end in itself, but rather must be considered within the broader community and economic objectives of the community. Of the four cities represented, two discussed benefits of operating systems considering expansion, one is brand new, and one is still in the planning stage.

The Hibbing, Minnesota, experience was presented by Jack Olin, assistant general manager, Public Utilities Commission. Hibbing has had a publicly-run DHC system for many years. There are 15 miles of steam lines supplied by three high-pressure boilers serving 1,500 residential, commercial, and institutional customers. A Phase II HUD feasibility grant has been received to evaluate expansion options.

Three areas are under consideration: 1) a predominantly residential area on the south end; 2) a junior college, county garage, and other customers on the east side; and 3) a chopstick manufacturing plant located about one-half mile from the steam plant. The HUD grant entails study of three problems, including whether the old system needs rehabilitation to deal with some pressure problems, whether the system should expand and at what rate, and whether the existing 35-year-old coal boilers should be converted to wood burners.

The economic benefits to the city are both immediate and long term. Immediate benefits accrue from the direct sale of steam which grosses over $3 million a year, of which about $300,000 is surplus. The Commission spends about $7 million annually on local suppliers, contractors, and consultants that, along with the multiplier effect, has a major economic benefit. The indirect benefits are derived from an assured long-term energy supply. Given sunk costs, even a doubling of fuel prices would have only a small impact on steam prices. The system has the capacity to double the amount of steam supplied. Although it does cogenerate, low avoided cost rates mean that almost all revenue is from direct steam sales.

In contrast to Hibbing's long experience with district heating, the Jamestown, New York, system is a fledgling operation. The idea started in 1981, with a New York State Energy Research and Development Administration-financed study, according to district heating coordinator, Douglas Champ. Few new jobs were being created in town to replace the many that had been lost, and district heating was seen as a catalyst to help reverse the trend. When the idea was first broached, it received rapid and strong backing from the Mayor and private sector leadership.

On the basis of favorable study results, the city decided to build a pilot plant to serve four customers: a 200-bed hospital, a factory with 200 employees, and two municipal garages, for a total cost of $800,000. The hospital alone reported first year savings of one-third of its $250,000 heating bill.

The success of the pilot project created immediate expansion interest. Six miles of pipe were added in 1985 to serve a high school, skating rink, and other customers, with the entire downtown slated for service in the next few years. With the nearby municipal power plant as the heat source, steam supply is no problem. Should the system grow further to serve an industrial corridor, an existing large industrial boiler may serve as a satellite source.

Although no studies have been done, there is evidence that the new system has already attracted development projects--new housing for the elderly, a 200-person manufacturing plant, incubator building for new businesses, and the regional headquarters of the phone company, with a

total of 100 new jobs. By design, the pipe runs past vacant, developable land. Additional future growth seems assured.

By contrast, the district heating project in Richmond, Indiana, is not yet a reality, despite several years of planning. The city of 45,000 just west of Dayton, Ohio, has lost population recently. As reported by Jock Pitts, Richmond's energy director, a 1978 Comprehensive Community Energy Management Program (CCEMP) grant from DOE produced a range of energy management options, of which DH was prominent. A HUD/DOE Phase I grant further defined the options, focusing on a small system that would pipe excess heat from a state hospital for a distance of about 1,000 feet to a rose grower with 40 acres under glass. Although project finances looked highly favorable and were further improved with receipt of an Indiana Emergency Jobs Program Grant, construction has been stalled because of policy differences among state agencies, and between the city and state.

Richmond is a national rose-growing center, faced with severe foreign competition. It is highly energy intensive, with 30 percent of the price of flowers paying for energy. The particular company to be served spend $640,000 for fuel in 1981. And the hospital boilers seemed an obvious choice, given their large size and proximity. In Pitts' view, delays in decision making result from:

1. A narrow outlook by some state agencies, such as the Mental Health Department, that fails to consider job creation as a byproduct of their main function;

2. Jurisdictional disputes. The boiler room at the hospital is operated by the State Department of Administration;

3. Lack of interest in getting involved in the sale of energy, despite excess capacity;

4. Currently lower energy costs, diminishing the project's urgency; and

5. Some potential environmental problems.

Overall the technical problems appear to be more manageable than the political/institutional ones. The problem of direct sale of energy to a private business has been resolved by assigning the municipal utility, Richmond Power and Light, ownership of the pipeline and selling the steam to the rose grower.

Should the project succeed, the company has agreed to sign a 15-year contract and probably add 35 new jobs. This would also give district heating a foot in the door in the city and generate further consideration of other projects, including use of the RP&L plant as a heat source.

The final speaker discussed a study now underway in San Francisco to consider how best to operate two existing, adjacent DH systems, one operated by Pacific Gas and Electric serving 200 customers downtown and the other owned by the city and serving the civic center. As presented by Richard Wakefield, of the Arlington, Virginia, consulting firm of Casazza, Schultz & Associates, options include abandoning both, renovating, and expansion, or some combination. A grant from HUD has been received for the study.

The civic center system is generally in good shape, although upgrading of pipes, meters, etc., is called for. Linking the two systems would cost about $2 million for the 5-6 block pipeline. Typical of dense, large cities, this cost can only be estimated because it is not clear what actually lies under the streets. It is attractive to the city to become a customer of PG&E to lower service costs and free up the centrally-located boiler plant site.

There seem to be few technical or economic obstacles; both parties are in favor, and negotiations are proceeding with the price of steam to the city a major negotiating point.

Unlike other utilities, PG&E has no desire to abandon its DH system. Although it has lost some customers recently, they

are mostly small and system load is relatively constant. With prodding by the state Public Utilities Commission, system management has improved and the company is now actively marketing.

Among new markets being considered is a major nearby redevelopment area. The customers have expressed interest, given projected cost savings of 25-30 percent over conventional fuels. The city sees greater economic benefits by encouraging system expansion into growing redevelopment areas rather than service to existing buildings. The scale of benefits has not yet been determined.

SESSION 14: State Programs and Policies

District heating development has been an integral part of Washington's state policy program for the past seven to eight years, according to Gordon Bloomquist of the Washington State Energy Office. Washington has an aggressive program that has been examining the legal and institutional issues affecting district heating and works to establish policy to try to attract district heating developers into the state. Bloomquist outlined two key strategies that have been used to promote district heating development in recent years. The first involves enactment of legislation about five years ago when a number of cities in the state were looking into implementing district heating projects. Some cities were given full autonomy to proceed as they wanted in developing their projects, while others were unsure of their ability to do this. Hence, legislation was introduced to guarantee the right of local government to own, operate, construct, and finance district heating systems. Additional legislation was also introduced to ensure deregulation of district heating systems (i.e., steam rates would not be regulated by the local utility commission) to encourage involvement of the private sector in district heating development. In anticipation of opposition from existing utilities, utilities were included in the legislation to also allow them an unregulated rate of return for district heating activities if they should be interested in entering the steam business. Furthermore, several provisions were included to ensure consumer protection along with private sector incentive. The proposed legislation was passed unanimously in both branches of the state legislature, indicating strong legislative support for district heating development in the sate of Washington. The second strategy used to encourage district heating has been an aggressive technical assistance program that involves hiring consultants to conduct preliminary studies to look at the feasibility of district heating in certain localities at the request of the local entity. This has generally been followed by application for additional funding from the U.S. Department of Energy if the study indicates favorable results with regard to district heating implementation for the locality under consideration. The state has also provided funding to communities whenever possible.

Fred Strnisa, program manager of the New York State Energy Research and Development Authority (NYSERDA) discussed NYSERDA's active involvement in the development of district heating in numerous cities throughout the state. Strnisa discussed the district heating systems in Jamestown and Rochester as the two major successes in New York today. NYSERDA's involvement with the Jamestown project dates back to 1981 shortly after HUD and DOE started their 28 Cities Program. Phase I was completed in late 1982 and in 1983 Phase II was initiated with project costs shared by the city and NYSERDA. In 1984 a pilot project was initiated and after one year of operating successfully was expanded into a full-scale system, which now serves about 20 buildings. The system has realized a 20 to 30 percent reduction of costs for its customers, with payback received on retrofit costs in less than three years. The amount of fuel being used to heat buildings on the system has been reduced by 40 percent as a result of cogeneration, the efficient retrofit of the buildings being serviced, and the conversion to coal which has replaced one million gallons of oil annually. District heating provides Jamestown with the opportunity to provide the industrial section with a stable, inexpensive coal-based thermal energy.

The other major success discussed by Strnisa was the district heating system in Rochester. Since it began operating in 1889, the Rochester system was owned and operated by Rochester Gas and Electric (RG&E) until December 1985 when it was sold to Rochester District Heating Cooperative (RDH). RDH was formed by the system's customers in 1984 after RG&E

was authorized by the New York Public Service commission to abandon the system. Once ranked as the fourth largest system in the country with 621 customers in 1961, the Rochester district heating system had over the years declined dramatically in the 1970s and 1980s and by 1985 had less than 100 customers. At present, RDH consists of about 40 members, delivers an annual load of 160×109 Btus per year and a peak load of 100 million Btus per hour. As in Jamestown, significant economic benefits are being realized by the reconfigured system. Members of RDH have saved about $12 million in avoided capital costs by not having to build individual on-site boilers and are presently saving about $300 per year compared to what was paid to the utility last year.

Pat Walker of the Michigan Energy Administration District Heating and Cooling Program discussed the program's approach to district heating development through the state of Michigan.

Initiated in 1982, the program approaches district heating as a four-phase process that includes: 1) reconnaissance; 2) Phase I - feasibility study; 3) Phase II - design/engineering and financial packaging; and 4) Phase III - construction and operation. Because of the lack of knowledge of district heating in most Michigan communities, the program has given special attention to the reconnaissance mission. This has involved pre-feasibility studies for numerous communities, with full-day workshops held in each community to educate people about the community development potential and economic advantages of district heating. The program's efforts have had favorable results: nineteen communities have received technical assistance in the form of feasibility studies and help in organizing efforts to pursue district heating; six communities have completed Phase I studies; four communities are actively pursuing funding for Phase I studies; and one community has completed a Phase II study and is deliberating construction. At present, there are three operating district heating systems--in Lansing, Detroit, and Grand Rapids. In summary, Walker outlined the major lessons learned about district heating development through their experiences in Michigan: the importance of full community participation; the importance of risk sharing; and the importance of technical assistance, not only for engineering concerns, but for organization efforts.

Minnesota's history of involvement with district heating dates back to fifty years ago, according to Frank Altman with the Minnesota Department of Energy. At one time there were about 31 municipal district heating systems operating in the state. Today there are 14 systems still operating, some of which are old and in need of rehabilitation or replacement, while others have been well maintained and are in good condition. Altman discussed the state's role in district heating development in Minnesota, emphasizing its partnership with local communities and the private sector in developing district heating projects throughout the state. The state has focused its involvement in three areas: 1) effort to promote the development of new systems and retain existing systems by ensuring continued support of the state in regulatory and legislative issues and providing financial assistance whenever possible; 2) creating opportunities for new systems to develop in the state; 3) promoting the use of indigenous fuels available in the state to decrease energy imports on which Minnesota depends for almost all of its energy needs. Since 1981, the state has provided technical assistance to communities interested in conducting feasibility studies for building new systems or retaining existing systems in need of renovation. It has also provided financial assistance to communities interested in developing district heating. State grants have so far assisted about 16 communities in the preliminary planning stage, and the state has also developed loan programs to help in financing design and construction costs.

SESSION 15: Cities' Presentations - Phase II Projects

Four cities taking part in Phase II gave status reports of their progress in the program, and also tied their studies into community and economic development. Moderating the session was Robert Groberg, director of the Energy Division, HUD.

The first speaker in the session was Pieter Dekker, manager of the electric department in Holland, Michigan, a town of 40,000 population. He is also director of the district heating project. He explained that the City of Holland owns its own municipal coal-fired power plant. The municipal power plant was selected for the producer of district heat because it is coal fired and close to center city.

As with other American cities, Dekker said, many businesses have moved to the suburbs, leaving the center of the city slightly deteriorated. The planning committee has geared its efforts to upgrading this area. The initial thought with district heating was to gear it to the downtown area to give the area the benefit of cheap energy with hopes that some businesses would stay there and others would be enticed to move there. In the early planning process, a circle was drawn around the power plant and the downtown area covering a one mile radius, with plans to concentrate the district heating in this area. It was also found to be economically feasible to tie in to retail business and housing. So, the strategy was changed to finding some anchor customers that are big enough to guarantee a certain revenue in order to finance the system. Three anchor customers were found. It was planned to provide steam to two of the customers and hot water to the third, a college.

After the costs were evaluated, it was determined that the total district heating system will mean that the community stands to gain a $2,400,000 savings by building a district heating system. It was felt there should be a demand charge as well as an energy charge. The demand charge should be covered by the debt service that would be incurred by going into the bond market to finance the system, and the energy should be out-of-pocket expenses. The price per million Btus was determined to be $5.21 to $5.63 to the customers. Since these are gas and oil users, these charges are economical to the customers, Dekker concluded, adding that customers stand to gain between 15 and 20 percent in savings.

The next speaker, David Henson, energy coordinator for Provo, Utah, said that Provo had completed construction of the first initial phase, and, on April 2, 1985, Provo officials broke ground on the system with the pipe installation.

Actual installation of the pipe was in May and the pipe is now ready to service the medical center which is one of the largest hospitals in the State of Utah, Provo High School, Provo school administration center, the LDS Seminary, and the LDS Church.

All phases of the project went smoothly to completion. Provo City reviewed a number of proposals by consultants and engineers, selecting RDA Engineering. Their concept of start small was exactly what Provo needed, Henson said.

The system is completed and operation and is producing hot water. Immediate plans are to design a second line to serve the downtown area. The requirements of the customers will determine what will be built. If hot water can service their needs, a much larger system will be developed.

Rita Norton, energy program manager for the City of San Jose, California, presented institutional barriers and the opportunities that the city sees as a basis for engaging in community-based services. There is no precedent for the city of San Jose to provide services such as energy. San Jose, a city with a population

of about 600,000 persons, is growing rapidly. The city is experiencing a major turnaround in the downtown area, with several projects underway.

In 1981 with funding from PG&E, the city did a study and found that district heating would be feasible. With approval for the construction of a convention center, the city council determined that this would be a starting point for a district heating system. The convention center superblock also includes two hotels, providing a balanced energy load.

Pre-Phase II work proceeded with another study to determine the feasibility of this particular project.

The system was sized for the maximum efficiency for the buildings surrounding the convention center, including the two hotels contiguous to the center, and the library. Two policy questions had to be resolved. They were: 1) should the city be involved in providing energy to private concerns such as a hotel; and 2) what is the PG&E role and what will be the impact on PG&E. As now envisioned, the project will have five different products: hot water, chilled water, power from the cogeneration system, and emergency power. The fifth is PG&E power. State law has been enacted so that a cogeneration system can provide electricity and heat (but electricity is the main issue here) to two contiguous users. However, PG&E has objected to San Jose selling electricity to the hotel. This will be settled in the next few months. The final design stage is now in the hands of the mechanical engineering firm that is a subcontractor to the master designer for the convention center. The hotel agreement is still ahead, Norton said.

At this time there are two studies being done independently by PG&E and the City of San Jose concerning the economic feasibility of providing energy through district heating/cooling and cogeneration. Neither of the studies is completed.

In summary, Norton said, San Jose is at a point where financing is secured, a project exists, ground has been broken for the convention center, and the final design contract has been executed. The final outcome, however, remains uncertain. One is a possible coventure on a superblock site with PG&E, and the other will depend on the outcome of the two expanded studies currently being undertaken.

The last speaker in the session was Charles Williams, director of energy management with the City of Chicago. Williams introduced his discussion by saying that the Chicago Department of Planning is attempting to bring new life into one of the city's older industrial areas with a district heating and cooling system. With a grant from the Department of Energy, the city spent several years surveying the city to find industrial parks, hospitals, college complexes, and other large energy users that could benefit from district energy systems. After numerous screenings and feasibility studies, the Stockyards industrial area was selected as one of the best opportunities for developing such a system.

With a grant from the Urban Consortium's Energy Task Force, Chicago personnel tried to identify participants for implementing a district energy system in the Stockyards. These efforts resulted in finding the Stockyards Energy Recovery Associates (SERA), a group of private developers that was formed to develop a resource recovery system in the Stockyards.

SERA has proceeded as a private sector development that is not dependent upon city participation. However, Williams said, in the summer of 1984, SERA met with the Department of Planning and the two groups realized that they were independently seeking the same overall goal: to get a district energy system built in the Stockyards. Thus, efforts were combined and the groups were awarded a HUD Phase II grant to work together to bring the project to financing by the end of the year.

Even though in SERA the city found a developer for a district energy system, it still needed to generate enthusiasm and local support. The catalyst proved to be

garbage. In January 1985 Mayor Washington proposed a ban on new landfills in Chicago and emphasized the need for exploring alternatives such as resource recovery and recycling. This brought the project to the attention of high-level city officials.

The SERA project can tie into the city's waste disposal plans as follows: The SERA facility will receive 600 tons per day of refuse. Approximately 100 tons of materials will be recovered, 450 tons will be burned in the incinerator, and about 50 tons will serve as backup or be transferred to landfill. This means that about 500 tons per day or approximately 5 percent of the city's refuse will be disposed of at the SERA facility.

The SERA facility will generate over 100,000 lb/hr of steam for Stockyard area companies. The facility is being designed primarily to generate steam, with electricity as a byproduct. Fluctuations in daily, seasonal and annual demand will be minimized since the baseload energy demand is primarily for industrial processing.

The SERA project had proceeded with plans to use waste collected only by private scavengers. Since receiving the HUD grant, financial underwriters have informed the city that it may be impossible to obtain bonding for the SERA project without the city demonstrating some commitment to provide refuse to guarantee the waste stream. Plans are now being reevaluated, with mutual benefit a likely outcome.

Williams pointed to three lessons learned from this experience: First, since Chicago's utilities are primarily natural gas and nuclear power based, they did not experience the same escalation of fuel costs after the oil embargo as many oil dependent cities did. Energy costs have not been as critical as they were elsewhere, and marketing district heating and cooling for its energy benefits has been difficult.

Second, within the city structure, there is no single administrative vehicle to undertake the planning, development, and implementation of a district heating and cooling system. This project cuts across a number of city departments and requires a large amount of cooperation which is often difficult to achieve.

Finally, waste is needed as a fuel to make the SERA project feasible, and the increased local attention to waste can help assure the success of this project. For those still trying to bring a district heating and cooling project together, waste disposal may be your key to success, said Williams. However, resource recovery adds a complex set of issues. Departments or agencies responsible for waste collection and disposal are still more interested in getting rid of garbage than in marketing energy.

In conclusion, Williams said he was pleased that local interest in waste disposal has brought the SERA project into the limelight. However, the challenge is not to let the underlying issues associated with the city's waste problems overshadow the vision for breathing new life into the Stockyards with a great district heating and cooling project.

SESSION 16: New Owners for Old Systems

Of increasing importance in the development of district heating in this country is the issue of alternative ownership. For many steam systems, this change in ownership has been directly tied to fairly aggressive plans for expansion and increased marketing of steam. As moderator for the session, David Gatton, director of policy analysis for the National Resource Recovery Association, stressed that choosing an ownership mode is best done according to what makes the most sense for the particular system under consideration. Decisions regarding ownership are a matter of taking into account what strategy would be most conducive to the successful development of district heating in a particular locality.

Armand Lartigue, president of the Rochester District Heating Cooperative (RDH), discussed the history of district heating in Rochester, focusing on the events that led to the formation of the cooperative in December 1985. Only the third steam cooperative in the country to be formed (after Pittsburgh, Pennsylvania, and Duluth, Minnesota), RDH has taken over as the new owner for Rochester's district heating system, which has been operated by Rochester Gas & Electric Company (RG&E) since 1889. In 1963 it was ranked as the fourth largest system in the country, serving 621 customers; by the end of 1985 there were less than 100. This dramatic decline in customers has been attributed to a number of factors, including: RG&E's aggressive marketing of natural gas; the decision in the early 1970s to convert from coal-fired boilers to fire natural gas or oil, which was shortly followed by the Arab oil embargo and the subsequent increase in steam prices; and an urban renewal program which eliminated most of the city's older buildings.

In 1984 the New York Public Service Commission awarded RG&E significant rate increases and authorized the utility to submit a plan to abandon the steam system by October 1985. A steam users group was formed by a number of the system's customers who felt that revitalization of the system was the preferred alternative, since this would preclude the need for capital investment in new boiler plant facilities and operators. The group began seriously considering the option of forming a steam users cooperative as a feasibility study was underway to assess the technical and economic feasibility of revitalizing the system. When the results of the study indicated the formation of a cooperative as the most desirable alternative, the steam users group moved quickly in planning and organizing the formation of a cooperative as the steam system's new owner. The group encountered resistance and often hostile reaction among the system's customers to the idea of a steam cooperative, but with hard work and perseverance the cooperative was formed. On January 12, 1986, RDH produced its first Mlb of steam and is presently generating approximately 65 percent of the system's requirements. Temporary boilers are being used while RDH awaits startup of its new boiler plant early next year.

Carl Avers, president of Youngstown Thermal Corporation (recently changed to Catalyst Thermal Energy Corporation), pointed to the Baltimore steam system as a role model for the smooth transition from a utility-owned system to one of private ownership. The success of this transition was related to Baltimore's active downtown revitalization as well as the utility's interest in continued service to its customers during the transfer of ownership to Thermal Resources of Baltimore. Avers emphasized the importance of regarding customers as the number one priority in the successful operation of a privately-owned steam system. New owners must be able to assure steam users of continued reliable service and long-term, stable steam prices. Thermal's business plan calls for: 1) an aggressive marketing strategy to increase steam sales and thereby reduce the price; and 2) conversion to solid waste as a fuel in order to stabilize steam rates.

SESSION 17: DHC and Community Development Programs

This session brought the case for DHC to the community level, focusing on visible ways such systems can support development programs in older cities. It featured two presentations about Springfield, Massachusetts, one from a development agency and the other from a DH company, and the comments of four people from a variety of perspectives.

The first presentation was by Carlo Marchetti, executive director of Springfield Central, a downtown business association successfully working to promote the area as a business center.

Springfield is a city of 150,000, although there are 550,000 people in its metropolitan area. Its downtown typifies older northeastern cities, with many abandoned buildings, a result of job and population loss. Springfield Central was formed to create a large mortgage pool for lending at below market interest rates for desirable projects in the core area. Projects have included rental and condominium housing, cultural facilities, retail businesses, and offices, along with substantial city investment in infrastructure. "Every possible" federal, state, and local financing tool was used, although most of the money has come from private sources, according to Marchetti.

Marchetti cited Springfield as a preeminent example of private/public cooperation. Given past successes, new projects are being initiated with no public participation, suggesting that the city may have turned the corner.

The proposed district heating system is seen as a means to tie much of the new and rehabilitated downtown together and further increase its attractiveness. Expected to initially serve a new hotel/office/commercial complex, the eventual waste-to-energy project may serve other parts of downtown and outlying areas, as well. To keep costs down and project timing consonant with project development, the system may initially be supplied by a temporary gas-fired, hot water plant with the waste-to-energy system built later.

The district heating perspective in Springfield was presented by James Tuller of Energy Networks, a subsidiary of the Hartford Steam Company. As consultant to the Springfield project, he described a two-way relationship between DHC and community development. Whereas a community development program can help provide DH customers, district heating can be a big incentive to a community development program:

- DH can lower a development's first costs by eliminating the need for a mechanical room;
- It can lower replacement costs in older buildings with aging systems;
- It can offer environmental benefits by having fewer smokestacks; and
- It can reduce operating costs 10-20 percent by using alternate fuels and technologies.

The Hartford experience shows that DH offers more reliability and more redundancy than conventional systems. One often overlooked benefit is simply the convenience to building managers of not having to worry about the heating system. Springfield Central recognized these benefits and initiated the exploration of DH in the downtown area, which gave the idea credibility with the business community.

At the same time, one major downtown developer has expressed no interest in DH despite evidence of substantial savings. He is unfamiliar with DH and is concerned about losing control of system and costs, as well as being unconvinced that the DH system will be ready when the building is completed. Thus, while the overall Springfield

atmosphere is positive toward district heating, aggressive marketing is still needed.

The four respondents offered a few comments about the link of DHC and community development. Fred Strnisa of the New York State Energy Research and Development Administration noted that the Springfield experience strongly supports the need for solid local leadership that can recognize and capitalize on the demonstrated cost savings of DH.

Chicago's deputy planning director, David Mosena, noted that in Chicago DH is an integral part of a resource recovery effort, given an increasingly critical solid waste problem. District heating is being considered within two parallel planning tracks:

1. A task force has found that the solid waste problem can be partly alleviated by recycling and some resource recovery, including converting waste to energy.

2. The economic development/ community development approach focuses on job creation and managing the city's transition from heavy industry to services.

Within these two tracks, the issue has emerged of where to place resource recovery plants to best help attract and retain jobs. The sanitation officials look to cut high transportation costs. Economic development officials look at waste to leverage jobs. District heating studies try to optimize both.

Current focus is on the Stockyards Energy Recovery Project within an old manufacturing district that now includes 31 companies employing 9,000 people. Pipes from an old DH system may still be usable for the planned trash-fired system. Needs here are to synchronize public and private development plans. Pressure on the city to quickly solve the garbage problem may mitigate against immediately serving economic development goals, suggesting the difficulties inherent in trying to meet the two sets of objectives.

Rich Carlisle of the National Association of Housing and Redevelopment Officials (NAHRO) pointed out that funding reductions provide incentives to both housing and redevelopment agencies to look for cost-saving measures. NAHRO is promoting exploration of innovative ways of finding, saving, or using funds. DHC is seen as one opportunity, but financing is difficult; the tax reform act may diminish incentives to use DH.

Finally, William Mahlum of the St. Paul District Heating Development Company identified a thread running through the previous speakers' remarks by asking whether DH leads or follows development. In St. Paul, he noted, a host of federal programs was used to promote development. The city needed a long-range plan to lower energy costs as a "linked" incentive to development. DHC provided this opportunity and now every major downtown building is connected to the system. With its heating benefits proved, the system is now looking at cooling.

There is no question that the system has been a big part of the CD/ED process; over $1 billion has been invested downtown in the last ten years. DHC is the link that ties the whole CD plan together over the long term.

SESSION 18: Cities' Presentations - Strategies for Expansion

Suzanne Beck of Springfield Central discussed Springfield's plans for startup and expansion of its district heating system, which is to begin construction within the next twelve months. The feasibility study determined a proposed service area for a fully-developed system that encompasses approximately 1,210 acres of the city, radiating from a downtown core. The sequence for startup and expansion begins with an initial system that will be contained within the central business district of the city in an area of about 157 acres. Expansion of the system will continue to the north and east of the city, a primarily industrial area, and then to the south which is currently a low density area targeted for high-density commercial development. From there, expansion will move south to a high-density residential district. Primary energy users for the system will include the City Hall complex and commercial and residential users. For the initial system, the prospective customer base was identified by looking at buildings with large loads and whose location is relatively close to the City Hall boiling plant, which will be the site for the new system's thermal source during its initial stage. Three thermal sources have been identified to supply the required energy for the system: gas-fired hot water generators that will replace an old heating system within the City Hall boiler plant, and modified turbines at a planned resource recovery facility and the West Springfield Generating Station are being looked at as sources for the expanded system.

In Salt Lake City, the existing district heating system serves about fifty customers. Unfortunately, the local utility which owns the system has not placed much effort in marketing the system. As a result, numerous opportunities to add more customers have been missed. According to Garth Limburg, the city will attempt to change this by involving the steam system in its current redevelopment project.

Limburg also discussed the strategies for expansion that are being applied in Provo where a publicly-owned electric utility that has been in place for some time has decided to get involved in the steam business. Since rates are controlled by a local elected city council, the idea of a district heating system has strong support from the community, which has a strong interest in energy independence and other benefits that can be realized by district heating. Without an existing steam distribution system already in place in Provo, plans for expansion call for developing a thermal market through the existing electric utility and begin building a base for a thermal network that will be serviced with heat from the utility's plant. Once the system is operating and expanded over time, the next step will be to add a refuse-fired steam plant as a component to the city's existing power plant. Because of the lack of a high density heat load in Provo, anchor heat loads had to be identified that would ensure the feasibility of a district heating system and to gradually work towards attracting more customers once this base load is secured. The project's initial phase has anchor customers that include a medical center on one end and a recreation center on another end, with other smaller load customers to be added in between these anchors.

Stanley Mulvihill of the New Haven Ninth Square Association discussed New Haven's plans for implementing a district heating system as part of the economic development objectives of downtown New Haven and specifically of the Ninth Square. With 110 property owners, the Ninth Square still has plenty of open space for new construction, and it is expected that over the next five or ten years approximately 1,000 residential units will be developed. At this stage, potential customers for a planned district heating system are being investigated, with a strategy similar to that applied in Provo of

securing anchor users on either end and gradually adding other customers later. Clearly, district heating offers an energy efficient and cost-effective method of heating and cooling not only the Ninth Square but also the rest of downtown New Haven.

The district heating system in Trenton has been providing steam to the city's downtown area for two years. According to Kevin Brown of Cogeneration Development Corporation, the owner and operator of the system, the system currently has 50 buildings online and expects to increase to 70 by the end of the year. This will fill up the system's capacity, and the construction of a sister plant is being considered to provide additional capacity to meet the growing load in downtown Trenton. Construction of a cooling system is currently underway. Customers include both very old as well as new buildings. Regarded as the urban growth capital of New Jersey, Trenton has a very aggressive economic development program, with more new construction per capita than any other city in the state, outside of Atlantic City. District heating is thus perceived as an economic development tool with tremendous potential for future growth and expansion.

SESSION 19: Municipal Refuse as an Energy Source

Using municipal waste as a fuel for district heating plants or using resource recovery/waste-to-energy plants to provide thermal energy to district heating plants was termed "a perfect marriage" by the speakers and the moderator during this session. Each focused on projects where district heating systems and resource recovery systems are codependent for energy and energy sales.

Don Walter, U.S. DOE, reviewed the history of using energy from municipal waste, discussing the use of waste as a fuel in Europe. When the center cities of Europe had to rebuild after World War II, district heating systems were constructed. Also, the Europeans are much more land-use conscious than the U.S. and do not want to use their land for garbage dumps. Thus, many European cities have turned to garbage incineration as a disposal method. In addition, environmental controls have caused waste plants to cool the exhaust gases in order to treat the air emissions. This process creates steam that can be used in district heating. The results seem to be a marriage made in heaven. And what is even better in Europe, all of these facilities are controlled by the cities. The large European systems have cogeneration plants using municipal waste to provide steam to the district heating system and also to supply electricity to the cities' electric systems.

The first speaker , Michael Gagliardo with the Northeast Solid Waste Authority of Maryland, discussed the authority's role in the development of resource recovery and district heating in Baltimore. He explained that the Northeast Solid Waste Authority is a regional financing and project implementation agency set up by the Maryland General Assembly in 1980 in response to severe solid waste disposal problems.

District heating began in Baltimore in the early 1900s with a downtown steam system that until recently was owned by the local utility, Baltimore Gas and Electric (BG&E). However, BG&E did not want to be in the steam heating business, and in 1979, it instituted a moratorium on adding new customers to the downtown steam system. With the formation of the authority and the decision by the city to replace a pyrolysis plant with a larger and more reliable waste-to-energy facility, the authority began implementing that facility on behalf of the city and surrounding communities. Plans were made to burn 2,000 tons per day of waste, producing 400,000-500,000 pounds of steam.

At that point, it made more sense to put in a turbine generator and sell electricity. The facility was designed and financed based on selling electricity, but with the project structure and contractual documents flexible enough so that when a thermal market became available, the thermal sales could be brought into the existing contracts, Gagliardo said.

Construction began in late 1982, and the facility became fully operational in May 1985 as a 2,250 tons-per-day plant producing roughly 510,000 pounds of steam per hour. A 60-megawatt turbine generator on site provides electricity for in-plant use, with the remainder sold to the utility company.

Two things brought about a resurgence of district heating in Baltimore. First, the city obtained one of the original HUD 28 Cities Grants for Phase I district heating analysis, and also the utility in 1983 announced it was preparing to sell the system to Thermal Resources of Baltimore.

The HUD program identified a number of potential systems, with one being an extension of the downtown system, and another a new hot water district heating system that would serve public housing. Both would have used energy from the Baltimore Resource Recovery (BRESCO) facility then under construction. In developing these projects the authority was

working with the city, BRESCO, and Baltimore Thermal. BRESCO's main function was to construct the waste-to-energy facility and get it operating so that the city could use it for waste disposal. Baltimore Thermal's main objective was to make a smooth transition into the operation of the downtown steam system, bring new customers onto the system, and stabilize the price structure.

One of the first things Baltimore thermal did after coming to town was work with the Authority and BRESCO to set up a contract whereby they would buy steam produced by the waste-to-energy plant to be used in the downtown system. This allowed them to offer stable prices to the customers when the system changed ownership. They basically adopted the existing BG&E rate structure.

The second likely project identified through the HUD grant was a hot water distribution system in the southern part of the city that would serve public housing, a number of schools, and possibly a hospital. That program has not progressed as far as the city and the authority would have liked. The city is still interested in the project, but it is on hold. However, the Housing Authority of Baltimore City did opt to revitalize the central heating system that was used to heat a large public housing complex instead of putting in individual building boilers. They are in the process of changing from steam to hot water.

In conclusion, Gagliardo said, The BRESCO plant is fully operational and steam was put through the lines for the first time in January 1986. Steam sales will begin in the next few weeks. This has given impetus to the downtown system and six new buildings have been signed on, prices are stabilized, and BRESCO is getting additional revenue from selling steam.

Frank Bernheisel, senior consultant with Gershman, Brickner & Bratton, Inc. discussed waste applications to district heating projects. Focusing on Springfield, Massachusetts, Bernheisel said that in 1982 Springfield sought to privatize both a waste-to-energy system and a district heating system, with each of the systems initially being separate entities.

After a feasibility study, a decision was made to start with a central core system using anchor customers. North Energy Networks was selected to be the owner/operator of the district heating and cooling system. Construction will begin in 1986, with customers expected to be on line before the end of the year.

The waste-to-energy project started at the same time. Groundbreaking was scheduled for April 1986 with startup scheduled for July 1989. The big difference in the timeframes necessary to do the different projects is a reason to keep them on parallel but separate tracks, Bernheisel concluded.

The next speaker, Jay Campbell, is vice president and department manager for the East Coast division of Henningson, Durham & Richardson. Discussing the refuse fuels project in Lawrence , Massachusetts, he pointed out that it is a private project but is supported by federal, municipal and other jurisdictions. It is a 1,300 tons-per-day refuse-derived fuel plant, a $90 million facility started in 1982 and completed in the last year and a half. The plant is two-part facility. One part is a process plant located in the City of Haverhill and the other is a boiler in the City of Lawrence, seven miles away. The plant has been up and operating at design conditions for the last six months. The $90 million included a 7,000-foot steam line which connected the plant with users. The boiler is a 250,000 pound spreader-stoker built by B&W, burning from 700-800 tons per day of refuse-derived fuel. The fuel has a heating value of about 6,500 Btu per pound. There is only one boiler. The three existing oil/gas fired boilers can pick up the load when that boiler is down. There also are five turbines used for generation of electricity, three condensing turbines with a total capacity of 17.5 megawatts and two extraction turbines.

Financing of the initial system was based on sales of both steam and electricity. The steam is delivered first to an adjacent industrial park with 15 users, whose steam prices are tied to the price of oil. There is an additional 7,000-ft steam line that services an industry and two housing projects. On the electric side, the facility can sell retail electricity within the industrial park where it is located. The balance is sold to the electric utility. With dropping energy prices raising concerns about meeting the project's financial obligations, contracts have been renegotiated from an avoided price contract to a fixed price contract with a separate utility.

Tab Schmidt, general manager of Thermal Resources of St. Louis, stressed the importance of energy markets to the economics of a facility and the value of cogeneration. He said that project viability is a two-way street, with St. Louis focusing on building the energy markets, while seeking to provide energy for downtown St. Louis at the lowest cost. His agency has worked toward using stable solid fuel, including coal and trash.

Schmidt said that over the last 10 years steam sales have decreased significantly, partly because of a rapid increase in steam prices. However, he said, he is looking at a rebirth of the central system through lower prices.

St. Louis generates about 7,200 tons per day of waste. The project is designed to start in 1986 with a 600 tons-per-day facility, although it can be increased to 1,200 tons per day on that site. The plant includes a mass-burn rotary kiln with a waste-heat boiler. There are two stages of pollution control, and air pollution will be four times lower than what EPA requires.

Steam from the facility will be sent to the district heating system. Any additional steam will be used to generate electricity for sale to the utility.

SESSION 20: Public Housing and DHC

HUD has always looked upon public housing as a natural client for district heating. Its most recent solicitation for Phase I assessments has been limited to cities in which public housing was expected to be an anchor customer. Bernard Manheimer of HUD's Office of Environment and Energy moderated this session and reported on the strong support for DHC by HUD's Assistant Secretary for Housing, Warren Lindquist, who showed support by attending the meeting. He reported that HUD is making a particular effort to find ways to save on public housing operating expenses in order to retain more funds for direct tenant-related costs. Incremental savings can have big payoffs, given HUD's $1 billion annual energy bill for its public housing.

The first speaker, Carl Adler of the Chicago Housing Authority (CHA), gave a detailed description of the CHA's experience with DH and exploration of new cost-saving opportunities. The CHA operates a huge system, with 150,000 residents in 50,000 dwelling units, and 1,300 buildings. Although originally oil-fired, most heating systems have not been converted to natural gas. Annual energy costs are $35 million, 36 percent of the CHA's annual operating budget. Ninety-two percent of this is for space heating.

Among conservation actions taken thus far are improved operating and maintenance procedures, repair and upgrading of heating systems, and some major retrofits. Although energy consumption has decreased, costs have remained constant as prices have risen. Management is now considering new technologies such as DH, and alternate fuels such as solid waste, of which the city has large amounts available for use as fuel.

A district energy plant using solid waste could have many benefits. A recent CHA study shows substantial cost saving opportunities in a seven square mile area south of the Loop that contains thousands of public housing units. Tentative plans call for building a 500 TPD plant about one-quarter mile west of Robert Taylor homes, the city's largest, in a state-designated enterprise zone. The site would contain truck storage, garages, mechanical systems, and possibly a recycling center. The secondary fuel could be gas or oil.

An additional benefit would be creation of a CHA-owned scavenger hauling service employing CHA residents. The Authority could use its eminent domain power to obtain rights of way for pipes.

Waste generated by its own buildings could provide 80 percent of the fuel needed for the 43,000 people in the area. Currently there are five central plants. The new system could make some use of the existing distribution systems. If practical, the system could also supply chilled water for commercial sale outside the CHA developments and thereby promote greater seasonal efficiency. Existing pants would be retained for peak use. Any excess could also be sold to other public or private customers; room is available for growth to 1,400 TPD.

Currently, a staged growth is planned. Also being considered is a wastewater purification plant with its dried sludge used for fuel. Finally, the study is considering a potential link with the nearby Stockyards Energy Recovery Associates project with the potential for the eventual creation of a single large system serving a substantial portion of the south side of Chicago.

A similar story, although on a somewhat smaller scale, was presented by Frank Amedia, superintendent of development and maintenance for the Youngstown, Ohio, Housing Authority. Current focus of his efforts is on the 609-unit Westlake complex which has undergone a few energy improvements. The existing aged district heating system requires substantial upgrading. The current proposal

is to retrofit the existing plant and enable it to burn natural gas or oil. Hot water would be produced and flashed to steam, with individual temperature controls installed in each unit. A $3.3 million low bidder was just awarded the contract to do the work.

Gas-fired temporary boilers will be installed during construction.

Although favoring modernization, Amedia pointed out the need also to consider the costs of short-term system disruptions. He also indicated that local HUD offices are not always familiar with innovative solutions and therefore are not always supportive.

He concluded with the following suggestions:

1. DHC system operators do not always consider public housing authority constraints and needs. They must be met at least half way.

2. DHC promoters should be more creative. Work through organizations such as the National Association of Housing and Redevelopment Officials and attend PHA engineering meetings.

3. Promote retrofit of existing public housing DH systems. Consider the legality of private ownership of public systems.

4. District heat must compete with other fuels.

5. Energy audits provide insufficient information to decide whether to proceed with district heating. Special studies are needed.

6. Keep HUD service offices up to date on thinking. They can be helpful.

Where consideration of district heating in both Chicago and Youngstown began with the initial intent of having public housing as the primary customer, the project presented next had a different focus. As discussed by Richard Kuo of the New York City Energy Office, the Brooklyn Navy Yard project was initially designed to have its industrial tenants as the anchor customers. With 12,000 public housing units immediately adjacent, however, the potential for marrying DHC and public housing emerged quickly, with the intent of using private financing as much as possible.

The highest priority project currently uses costly high-pressure steam to serve the 5,000 units. The other has a 32-year-old system in poor condition. The New York City Housing Authority (NYCHA) asked the Energy Office to investigate expanding the Navy Yard feasibility study to consider possible DH service to their buildings.

Preliminary results indicated that service to the Housing Authority project would add $4 million in capital cost. It also showed potential for saving the NYCHA a substantial amount in annual energy costs. After extensive negotiations, agreement has just been reached for service to be provided. Negotiations were complicated because the Housing Authority is only permitted to pay for service it received, i.e., it cannot sign a long-term take-or-pay contract. In addition, the Authority is constrained because HUD pays only for ongoing costs and not for capital replacement.

A final issue was what to do about warm winters, which would lower costs to the Authority but place a serious financial burden on the system owners.

A rather complicated agreement was drawn up to balance all these concerns. It calls for four different price levels that, in essence, increases unit cost the less that the NYCHA buys, and lowers it if more energy is used. This protects the owner's revenue stream and allows the other customers--in the Navy Yard--to be treated equitably. Thus, no preference is given to any customers.

Overall, the Housing Authority will account for about one-third of total system

revenues, $5 million/year, while saving $500,000-$900,000 annually. It also will reduce its manpower requirements.

For the system, the assured long-term NYCHA revenues are crucial to long-term financial viability. and adding the Authority's load helps keep prices down for the other customers. Financing is now in place, pending approval of a UDAG application by HUD.

In the question and answer period, considerable interest was expressed by attendees in having a followup, one-day session devoted entirely to the connection of public housing to district heating and cooling.

SESSION 21: DHC Development: The Private Sector Perspective

Quoting Charles Dickens to sum up the current status of district heating, featured speaker Thomas R. Casten, president of Cogeneration Development Corporation said: "It is the best of times; it is the worst of times." The district heating pendulum, he explained, swings from one extreme to another and, if we are patient, we can ride out the bad times.

Five years ago, he pointed out, we were being held a virtual hostage to oil-producing nations, with oil at $35 a barrel. At that time, forecasters were predicting that gasoline prices would be at $2 a gallon in 1985. Today, the opposite is true. Oil is below $20 a barrel*, and forecasters were talking about gasoline pump prices under $1. While these lower prices may act against investment in district heating, other trends are working in its favor. For example, there have been tax law changes that may have a profound effect on the way district heating projects are financed.

Against this background, Casten outlined advantages and disadvantages of district heating. Common sense must be applied, he said, where the system is owned by one entity and it is serving others, particularly multiple customers. The process is greatly eased where there is an intervening political entity both to grant necessary permits and, where appropriate, to take the flack.

Among benefits of district heating are reduced reliance by customers on more expensive fuels. In Trenton, for example, an apartment house now served by Casten's company would be buying gas at $6 million/MM-Btu; the district heating company can buy it at $4.

Single-user boiler plants are usually too small to be run efficiently and they often produce more pollutants, partly because of poorer maintenance and operation. Some of district heating's benefits may result from economies of scale.

Other characteristics of district heating include:

1. It offers a city long-term, stable heat source.
2. It encourages city development.
3. Where properly located, district heating systems can expand and offer wider benefits.

At the same time, he offered cautions growing out of his experience with several projects:

1. The process is complex and time consuming. A long-term commitment is required.
2. Cogeneration, offering more than one revenue source, makes a system much more economically viable.
3. The financing process is fraught with frustration.
4. Fuel costs and/or savings strongly influence financing and, eventually, project survival.

In conclusion, Casten said he expects fuel prices to rise, causing the pendulum to swing again in a direction more favorable to district heating.

*By early April 1986, it was approaching $5!

SESSION 22: Mayors' Colloquium

This session provided six mayors with an opportunity to briefly give their perspectives on the benefits, and some problems, of district heating development in their cities. Master of ceremonies for this always-entertaining session was the mayor of Lincoln, Nebraska, Roland Luedtke.

Leading off was Ogden, Utah's mayor, Robert Madsen, saying that district heating is helping to revive an economically dead downtown that is being revived through tax increment financing and revenue bonding, resulting in a new 20-acre mall. The city hopes to use district heating as a major future redevelopment tool. In the district heating assessment begun last April, Mayor Madsen continued, the city is determining downtown energy characteristics, and he is optimistic about the energy and cost savings that may result.

Renville, Minnesota, is at a similar assessment phase, reported its mayor, Douglas Henning. Renville, a town of less than 2,000 people, is the home of a sugar beet factory that processes 60,000 acres of beets a year. During processing, the plant has an output of 10,000 gallons per minute of 140° water. With the plant only 1-1/2 miles from downtown, there may be real opportunities to use this heated water as a resource. Among potential customers are a school, nursing home, and grain elevator, as well as the downtown commercial area.

The old mill city of Lawrence, Massachusetts, was represented by its mayor, Kevin Sullivan. The idea of district heating was introduced to the city in the late 1970s and took shape in 1980 when Lawrence and its neighbor, Haverhill, jointly applied for UDAGs of $4 million each. Receipt of these grants enabled leveraging others funds to create a large thermal conversion project. A resource recovery center is located in Haverhill, to which trash from several nearby communities is trucked and converted to refuse-derived fuel (RDF). The RDF, in turn, is trucked to Lawrence where it is burned in a thermal conversion facility converted to steam and piped into a district heating system. Customers include two public housing complexes and 25 industries in an adjacent industrial park. Cogenerated electricity provides another revenue source. Financing has been a problem, said Mayor Sullivan, making it difficult to expand. But he expressed confidence that service can be expanded to serve Emerson College, planning to relocate nearby.

Adding to the diversity on this panel was a brief discussion of the existing Youngstown, Ohio, system, now 100 years old. Mayor Patrick Ungaro noted that the existing system ties in the university, some public housing, and the downtown area and is considered an important economic development tool. Its Phase I funds are assessing expansion possibilities.

Note: can't complete--don't understand MM

Another success story was presented by Mayor Steven Carlson of Jamestown, New York. On October 1, 1985, the city achieved a major milestone in the phased development of a new district heating system. A pilot project started just the year before was expanded from four customers to serve 15 additional customers, including two hospitals, city hall, a federal building, a 112-unit HUD-sponsored senior citizen project, a 150-employee factory, and several others. Its economic development benefits are clear, said Mayor Carlson; a large regional telephone company is expected to move its New York State and northeast regional headquarters to Jamestown, with a new office building tied to the district heating system. The company identified the cost savings of district heating as an important influence on its decision.

Not to be outdone by his colleagues, Lincoln's Mayor Luedtke kept the last words

for himself. Lincoln's own project is unique, he said, because it expects to use city wastewater effluent as the heat source in conjunction with a heat pump system. Although widely used in Sweden, it is considered innovative in the United States. Timing of construction is crucial, because the city is negotiating with a developer interested in a $64 million downtown redevelopment project. This, and the historic Haymarket district, will both be served by district heating. Luedtke pointed out that using wastewater for district heating is an "ultimate" recycling project.

In the diversity of their cities, the district heating systems they have or are designing, and the services they expect to deliver, these six communities are a microcosm of the entire conference. These mayors clearly are convinced that district heating is a major mechanism to tie together development and redevelopment plans.

SESSION 23: DOE Bidders' Briefing

Regulations and suggestions for persons interested in responding to a request for proposals to conduct feasibility studies for a Phase I district heating and cooling effort were discussed during a bidder's briefing chaired by Floyd Collins, Office of Buildings & Community Systems, DOE.

One of the most important details and one that could make a proposal ineligible is the entry deadline, Lynn Warner, contracting officer from the DOE procurement office emphasized. Warner stressed that all proposals must be in Room 1J005 on or before the stated closing date of 4:30 p.m., February 28, 1986, or they would not be considered for evaluation.

Warner also stressed that persons planning to submit proposals read the RFP thoroughly before beginning work on the proposal. Wyndham Clarke, Office of Environment and Energy, HUD, seconded this advice.

A review was made of the evaluation criteria outlined in the RFP. It was noted that the selection panel rating the proposals would be constrained to using the written criteria as follows:

1. Opportunities for district heating and cooling systems would be evaluated as demonstrated in the proposal, with an awareness of the physical and economic opportunities for a successful system considered.
2. Quality of applicants' capability and commitment, the extent of capability for assessing a successful project, and a city's commitment to move forward with a project if the study determined it feasible would be considered.
3. Makeup and demonstrated involvement of an assessment work group would be assessed.
4. Consideration would be given to the clarity and conciseness of the proposal.

Clarke also discussed the relative importance of other criteria, pointing out that some of these include the geographic regions, size of the cities, and consideration of cooling, waste-to-energy systems, and housing.

Allen Kennedy, Argonne National Laboratory, outlined the first steps that grant recipients would go through, pointing out that after the last award session, a kickoff meeting was held with project managers. The next step was for each project to prepare a detailed work management plan, a milestone schedule, and to indicate resource allocations.

Warner concluded that approximately a half-million dollars will be available for awards, with most awards in the range of $30,000 to $40,000.

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